Coal Age

1956
MINING GUIDEBOOK

AND BUYING DIRECTORY ISSUE

MID-JULY, 1956 A McGRAW-HILL PUBLICATION PRICE 50¢

Laytex® Royal Master Portable Cables

"Coal mine shuttle cars are cable killers," says chief electrician. "But see the 'U. S.' Cable under wheels of this car—it takes this punishment many times a day."

Car brings coal to loading point, and 'U. S.' Cable is reeled in until snubbing post (at left) is reached. Car runs over cable, pulls it against sharp ribs, around bends."

Note high flexibility of U. S. *Laytex* Royal Master in unloading operation. "We reel it in and out about 300 times a day. In every way it's the best portable cable we ever found."

"These cables last at least 5 times longer than any we've ever used,"
says chief electrician of coal mine

U. S. *Laytex* Royal Master Portable Cables are put together by men who know how to make a cable stand up. U. S. Royal Master "rolls with the punch" when hit. "Your cables have been on the job for 2 years, and we expect years more of service from them," says this veteran mine electrician. "It is the long-lived cable that's been needed for many years in the coal industry."

U. S. *Laytex* Royal Master Portable Cables are obtainable from your "U. S." branch, distributor, or by writing to United States Rubber Company, Electrical Wire and Cable Department, Rockefeller Center, New York 20, N. Y.

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United States Rubber

EVERYTHING you need for ROCK BOLTING

from bit to compressor

CARSET JACKBITS

RP-38 "SHORT LEG" STOPERS

SIZE 534 IMPACT WRENCH

TYPE 40 COMPRESSORS

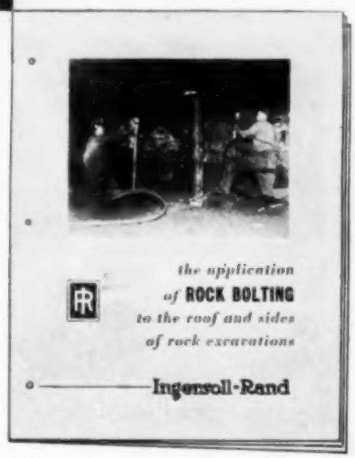
Ingersoll-Rand equipment helps you do a better job at rock bottom cost

CARSET JACKBITS last longer and drill more feet of hole between regrinds. They cut bolt-hole drilling time 50% or more.

RP-38 "SHORT LEG" STOPERS are easy on the operator. They make light work of drilling bolt holes and driving wedge-type bolts. Available with standard or telescopic feed leg.

SIZE 534 IMPACT WRENCH tightens all roof bolts quickly and easily—without kick or twist to the operator. Wide range of extra-deep sockets permits tightening nuts over extended bolt ends.

TYPE 40 COMPRESSORS provide an ideal air power source for rock bolting work. These compact, electric-driven, two-stage units require no cooling water—no permanent foundations. Dust-tight, economical, easy to install or move about. Available in sizes 25 to 100 hp for pressures from 80 to 125 psi.



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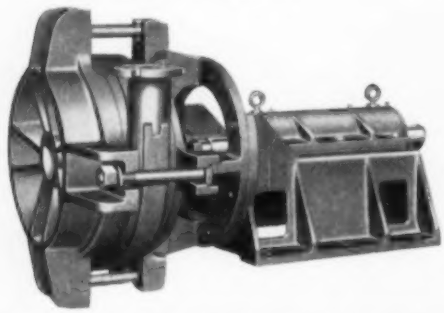

MORRIS type "RX" SLURRY PUMP

. . . for continuous 24-hour pumping of **Ore Slurries, Tailings, Concentrates, Abrasive Mixtures**

- **Simple design.** No internal studs or bolts—no troublesome internal joints and fits.
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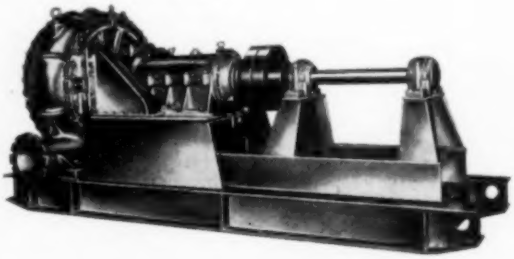
Widely used in both metallic and non-metallic mines and mills. Sizes 2" to 8". Write for Bulletin No. 185.



MORRIS type "GA" and "GAF"
HEAVY DUTY DREDGE PUMPS

Small high speed or large low speed units for pumping abrasives against high heads

- **Giant shaft.** of high-grade steel withstands vibration, handles shock loads easily.
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- **Economical impeller design.** With external cleaning vanes on both sides. Enlarged suction shroud seals on nose.
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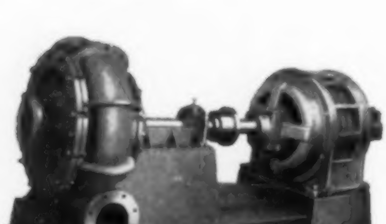

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The Standard Pump in Many Mines for Coal Cleaning

- **Low speed, wide clearance** for continuous low-wear non-clog solids pumping at lower cost.
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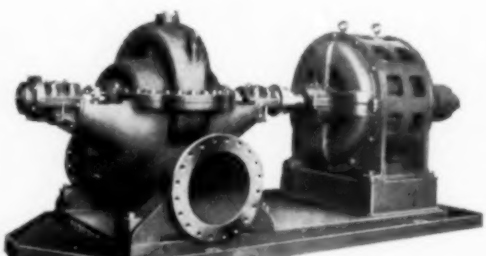

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For Drainage and General Service

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- **Extra-heavy shaft** of tough, hard alloy steel.
- **Upper part** of horizontally-split casing easily removed without disturbing suction or discharge piping.
- **Heavy-duty, precision ball bearings** mounted in dust- and moisture-proof housings.

May be connected in series for higher heads. Sizes: 2" to 220". Send for Bulletin No. 179.

GENERAL INDEX

Mid-July, 1956

THE Coal Age

Mining Guidebook and Buying Directory Issue

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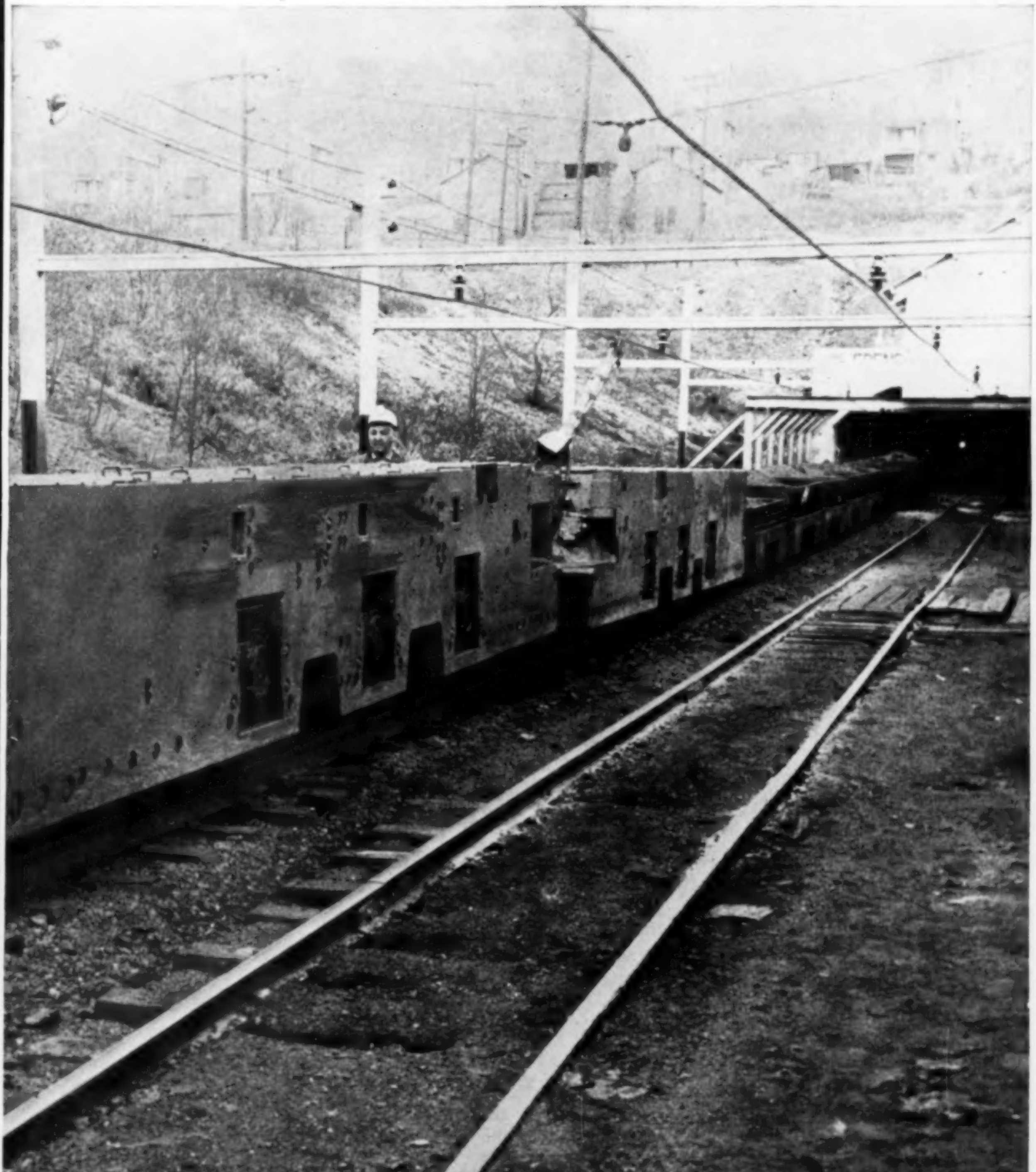
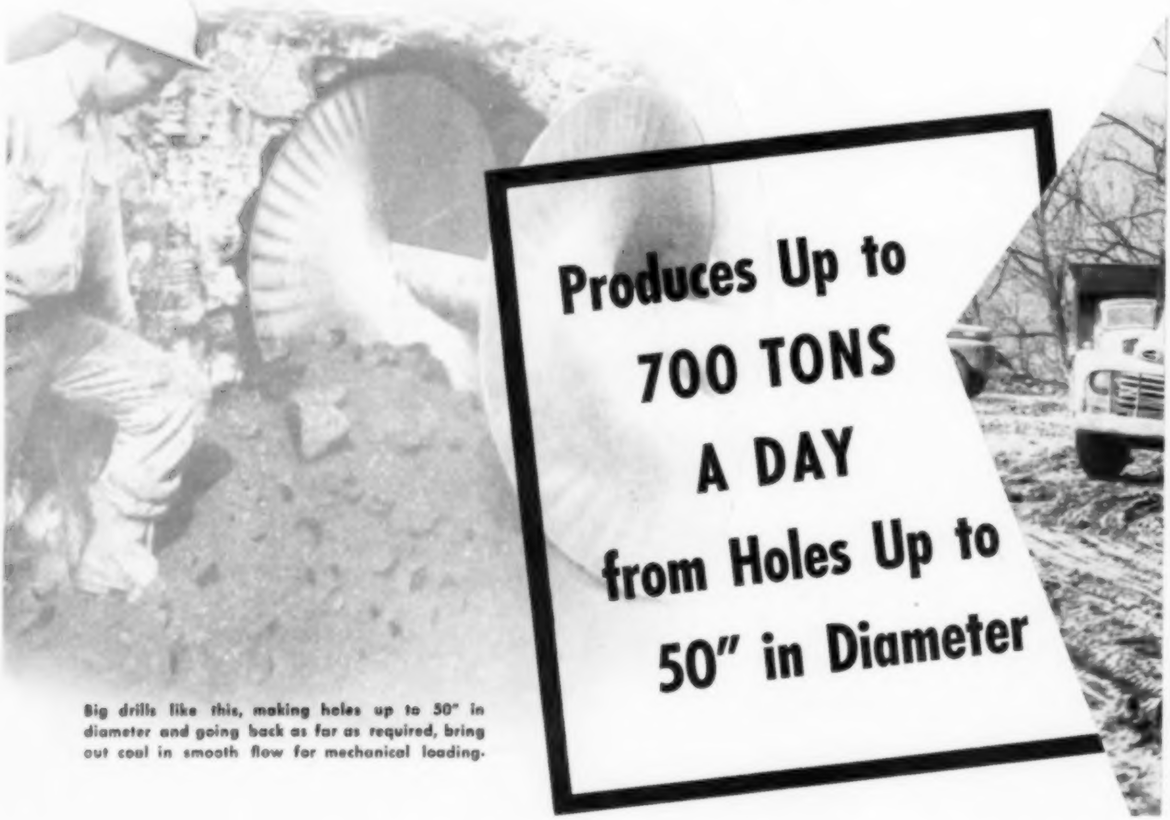


LUBRICANTS for the Coal Mining Industry

New-Bigger -More Rugged



Big drills like this, making holes up to 50" in diameter and going back as far as required, bring out coal in smooth flow for mechanical loading.

Here, we believe, is the cheapest coal mining method yet developed, on a per-ton basis. Salvaging pure coal otherwise "lost" because of excessive overburden, the new CARDOX Model 235 can operate easily in any 26-foot pit —takes only a three man team. Because it is self-positioning by hydraulic jacks and self-moving, the No. 235 spends *more* time working, *less* time moving from hole to hole. Auger changes are quick and easy. With the Auger-Miner spanning *two* holes, augers are stored in the completed hole and recovered as needed for the new hole being drilled. Its extremely rugged construction means less maintenance,

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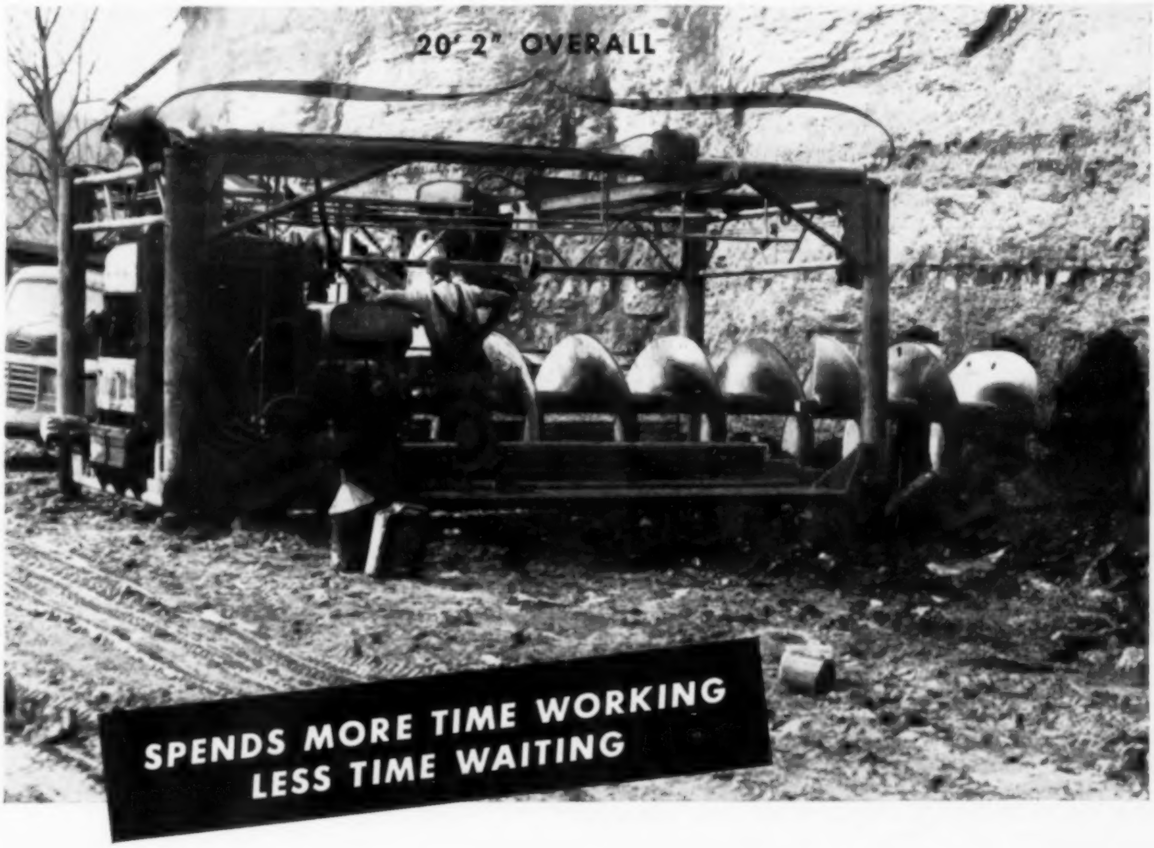

while simple design makes such maintenance easier.

Get the full facts now on how the CARDOX Model 235 AugerMiner may help you get the most economical, profitable coal you've ever mined. Write and we'll arrange a meeting with a CARDOX Engineer.

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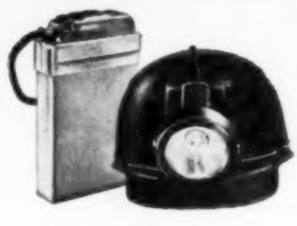
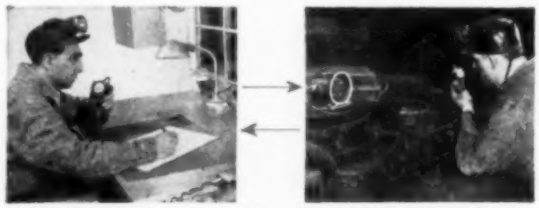

Edison R-4 Electric Cap Lamp


Edison Permissible Electric Trip Lamp

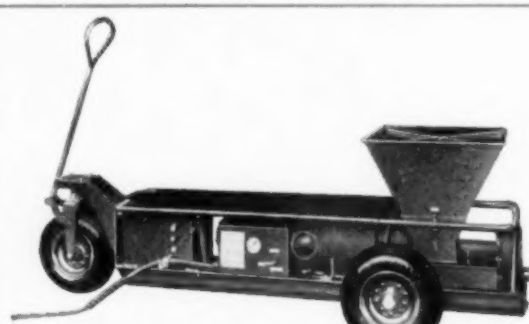
COMMUNICATIONS

M-S-A MINEPHONE—Sends dispatcher's orders instantly and simultaneously to all motormen, who can receive and reply while trips are in motion. This clear, two-way voice communication keeps trips moving, minimizes waits on sidings. Repair needs are relayed in seconds. Over-all safety is improved because one message alerts all personnel at once.


M-S-A MinePhone keeps haulage in step with mechanization.

ROCK DUSTING

M-S-A BANTAM 400 ROCK DUST DISTRIBUTOR—This versatile unit discharges 30 lbs. per minute through 400 ft. of hose, or 100 lbs. per minute through 25 ft. of hose. Its low height makes it ideal for low coal application, and for transporting on any belt or pan conveyor with 16-inch clearance. Because of its 400 feet of hose, airways and rooms can be completely dusted without removing the unit from the belt or other haulage equipment. Small size makes storage easy. Also used for fire fighting and wet rock dust application. Other types available for a variety of rock dusting needs.


M-S-A Bantam 400 Rock Dust Distributor

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M-S-A METHANE ALARM—Continuously samples air at working face. Flashing red light warns miners of hazardous concentrations. Automatic; portable; can be mounted. **M-S-A METHANE RECORDER**—Continuously charts methane concentrations in return air. Accurate safety check against unusual gas conditions. Serves as guide for regulating volume of air to maintain proper and economical ventilation standards. Records, and gives visual and audible warnings. **M-S-A—WOLF JUNIOR FLAME SAFETY LAMP**—Dependable, steady flame, guarded by improved ventilation. Easy-to-read graduated chimney. **M-S-A METHANE DETECTOR W-8**—Instant, accurate reading of methane. Ideal for spot checking. Light; portable. **M-S-A METHANE TESTER TYPE E-2**—Pocket sized unit. Indicates methane as low as .2%.


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When you have a safety problem, M-S-A is at your service. Our job is to help you.

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Greater Safety—Check Here M-S-A

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M-S-A Self-Rescuer


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M-S-A Chemox Oxygen Breathing Apparatus


M-S-A McCaa Two-Hour Oxygen Breathing Apparatus

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M-S-A Comfo Cap


M-S-A Glass Fiber Hat

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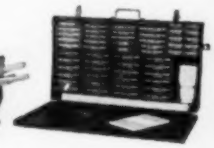
M-S-A First Aid Kits


M-S-A Emergency First Aid Outfit


M-S-A Miner's First Aid Cabinet

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M-S-A PNEOLATOR—Completely self-contained artificial respiration device. Supplies oxygen under intermittent positive pressure, automatically. **M-S-A PULMONARY VENTILATOR**—Effective intermittent positive pressure for the treatment of many respiratory disorders. Provides complete respiratory tract distribution of aerosols.


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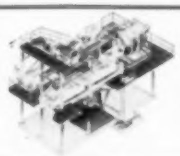

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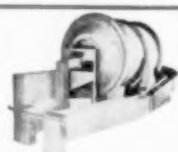
World's most widely used heavy media separation plants; available with a choice of separatory vessels; capacities 25 to 500 TPH; will handle feed range from 8" to 3/32".



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Two-gravity, three-product heavy media separation in one vessel. Less than 1% misplaced material on a feed of 114 TPH of 2½" x ¼" coal indicated in typical operating report.

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Separatory drums and cones, densifiers, medium pumps and media reclamation circuits of the superior designs so thoroughly proven in the Wemco Mobil-Mills.

WEMCO TORQUE-FLOW SOLIDS PUMP

A remarkable new pump that can handle chunks up to several inches in diameter; available in capacities 100 to 3,000 GPM; handles heads up to 120 feet.

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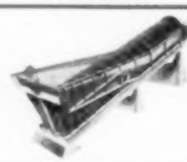
Most efficient per cubic foot of all modern flotation machines. Extract saleable coal in the range from 14 to 325 mesh plus solving disposal problem.



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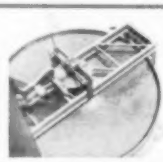

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High capacity means for making an efficient separation in the 200 mesh range; used to deslime coal ahead of tabling or flotation; diameters to 150 feet.

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All necessary tests are available to determine practicability of various coal cleaning methods for treating your run-of-mine coal.

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The perfect compromise between acreage and horsepower in clarifying water for closed circuits, or for pollution-free stream disposal; diameters to 400 feet.

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WESTERN MACHINERY COMPANY

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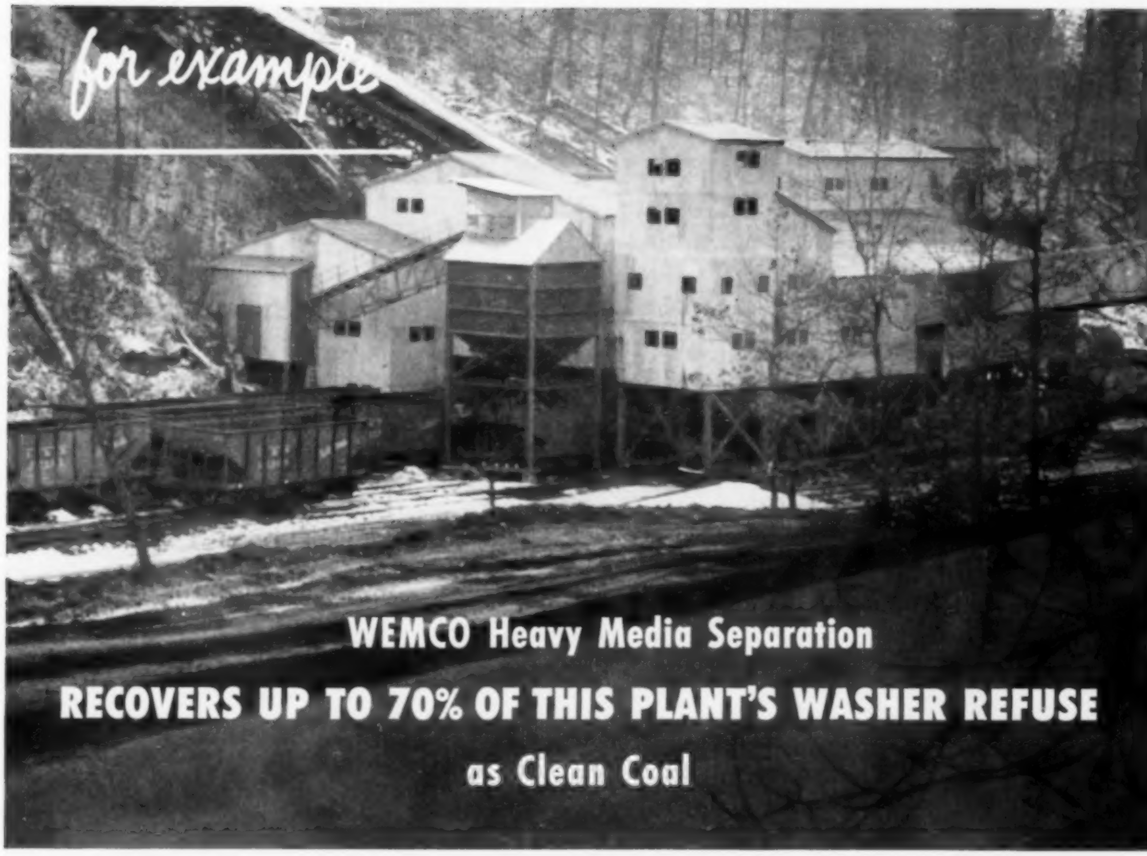
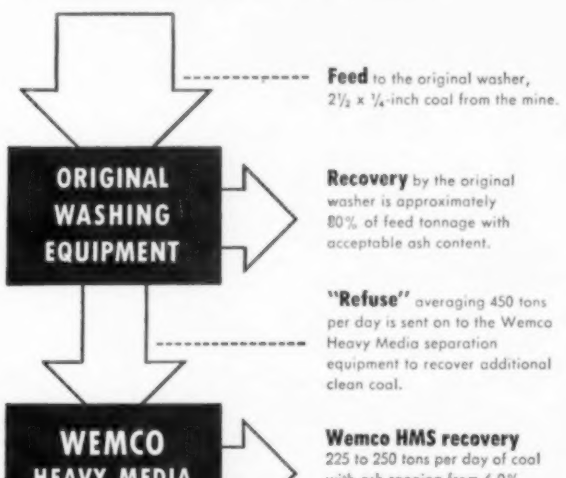
The full available information on any of the above equipment items will gladly be mailed in answer to your inquiry. More detailed recommendations for your specific coal cleaning problem will also be furnished, if desired. Write Dept. W



The Jewell Ridge story at a glance



"We are now recovering 225 to 250 tons per day of clean coal that was formerly lost," says the Division Engineer at Jewell Ridge Coal Company in Tilford, Kentucky.

Lab analysis at Jewell Ridge had shown a large loss of coal in the refuse of the original washing plant. A Wemco Heavy Media plant (of Mobil-Mill design) was added to treat the large volume of refuse. It was expected to recover a coal of 11 percent ash, saleable at a low price. But in actual operation, the Wemco Heavy Media equipment has been recovering 225 to 250 tons per day of coal in a range from 4.8% ash to 6.0% maximum. (Jewell Ridge Coal Company has now ordered a second Wemco Heavy Media plant.)

A Wemco HMS Mobil-Mill can earn extra profits on your mine too. Write today for full information.

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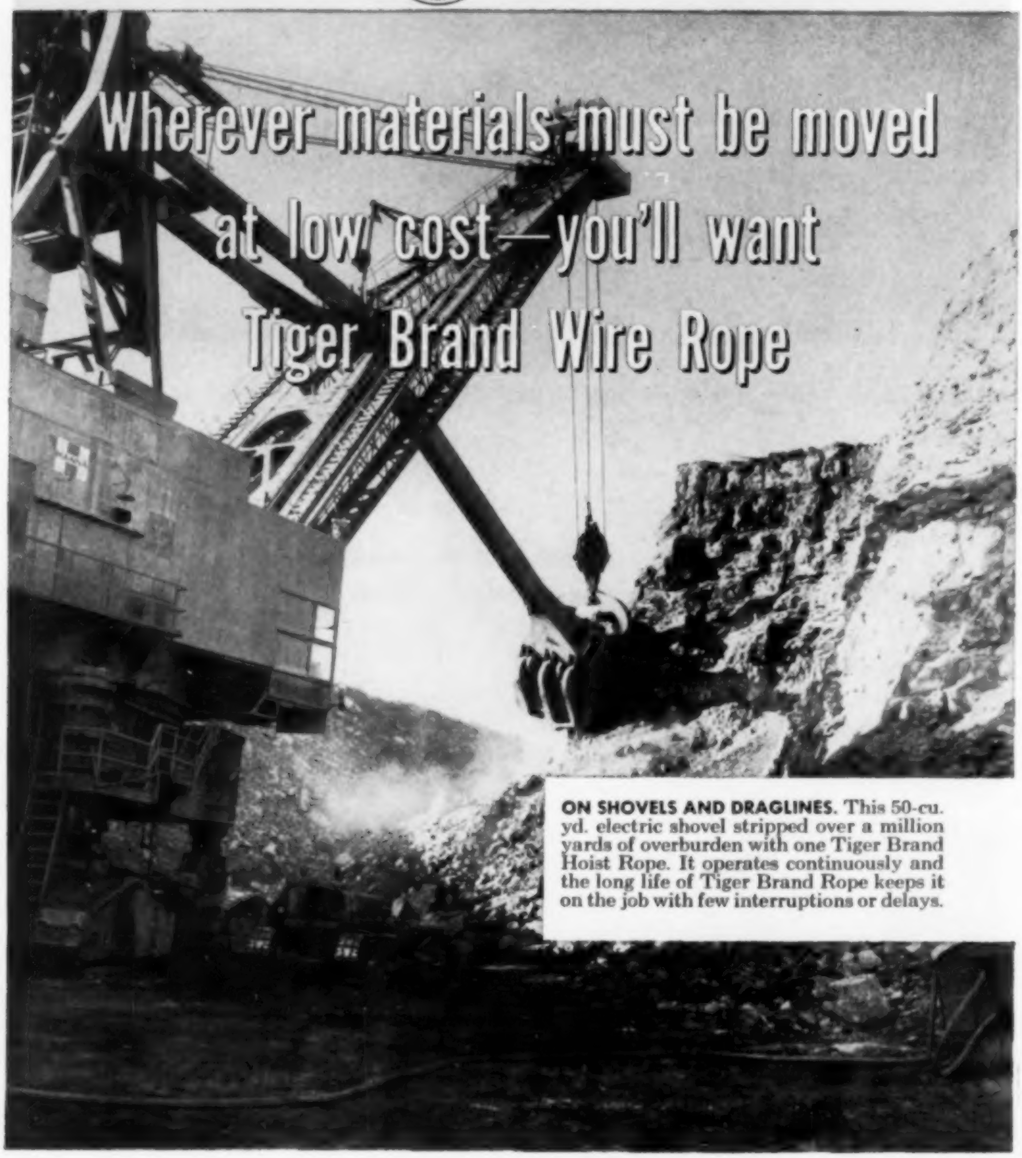

ON SHOVELS AND DRAGLINES. This 50-cu. yd. electric shovel stripped over a million yards of overburden with one Tiger Brand Hoist Rope. It operates continuously and the long life of Tiger Brand Rope keeps it on the job with few interruptions or delays.

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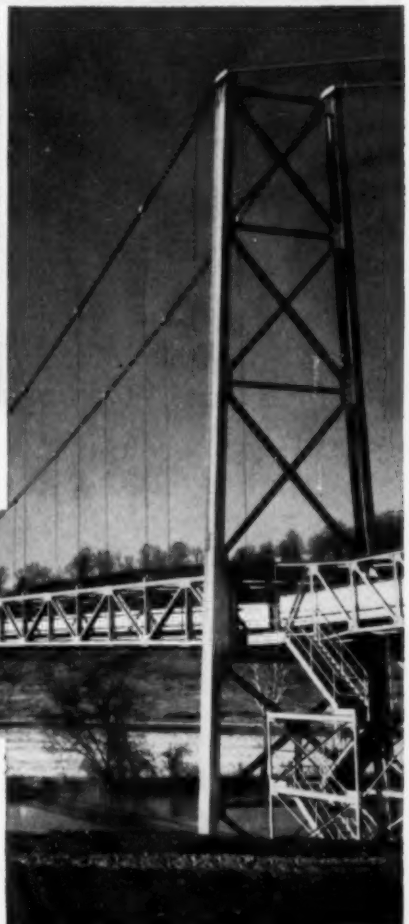
UNITED STATES STEEL EXPORT CO.
30 Church St., New York, N. Y., Export Distributors

FOR TRAMWAYS. In 15 years, this tramway has hauled over 2,000,000 tons of material at exceptionally low cost. Service is rugged because of abrasive dust clouds, but Tiger Brand is built to take the punishment.



FOR CONVEYOR SUSPENSION BRIDGES. Coal crosses a river in one jump with no costly extra handling on this 575-foot conveyor bridge. Two Tiger Brand main cables, each composed of four 2" dia. prestressed, galvanized bridge ropes and 44 vertical suspenders of ⅞" prestressed, galvanized rope support the bridge.

American Steel and Wire Division makes every type of wire rope, sling and boom support you need. There's a distributor near you for quick service. Look for his name in the classified telephone directory.

USS AMERICAN TIGER BRAND WIRE ROPE

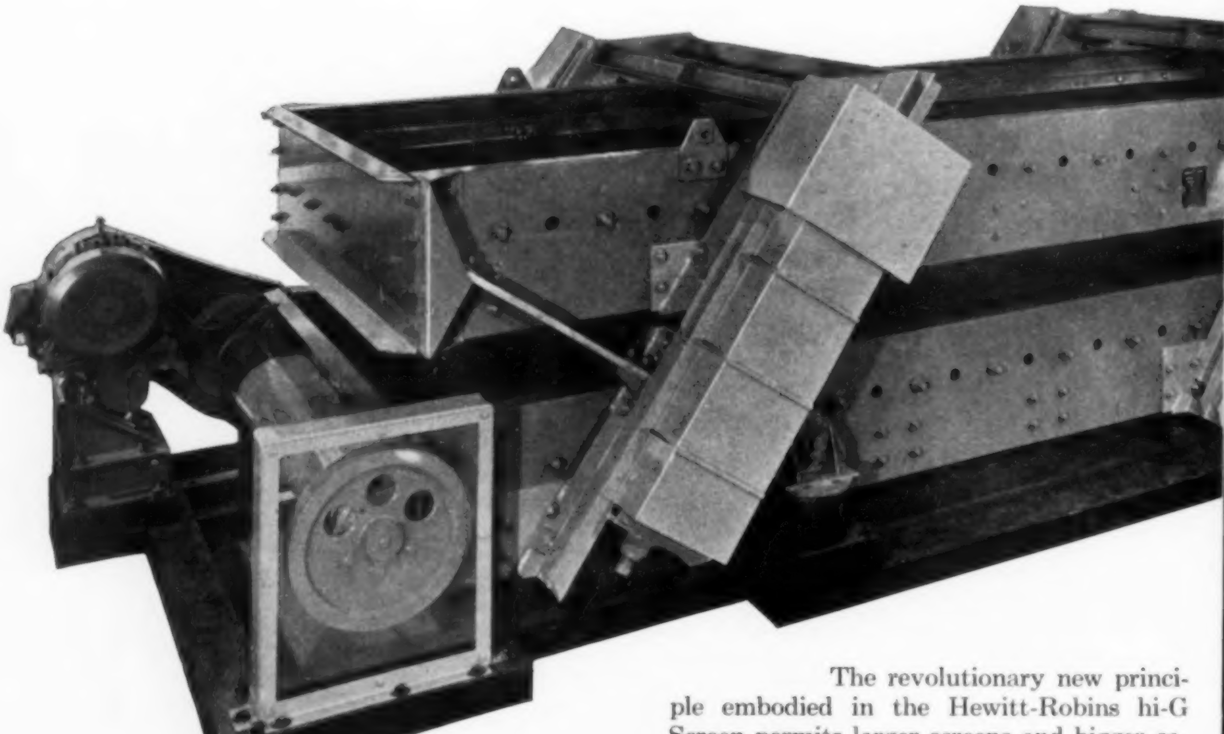
Excellay Preformed

USS

UNITED STATES STEEL

HEWITT-ROBINS *hi* G SCREENS

50 Per cent Savings



The revolutionary new principle embodied in the Hewitt-Robins hi-G Screen permits larger screens and bigger capacities. Yet the hi-G operates on 50% less power than conventional vibrating equipment! Even screens as large as 6' wide by 28' long require no more than a 20-HP drive.

Featuring an unusually sharp screening action, and a choice of stroke and speed combinations, the hi-G can be made in larger sizes than any other vibrating screen on the market.

New "Modified Resonance" Principle

Utilizing the principle of "modified reso-

INDUSTRIAL DIVISIONS PRODUCTS

VIBRATING SCREENS • VIBRATING CONVEYORS

CONVEYOR BELTING • CONVEYOR MACHINERY

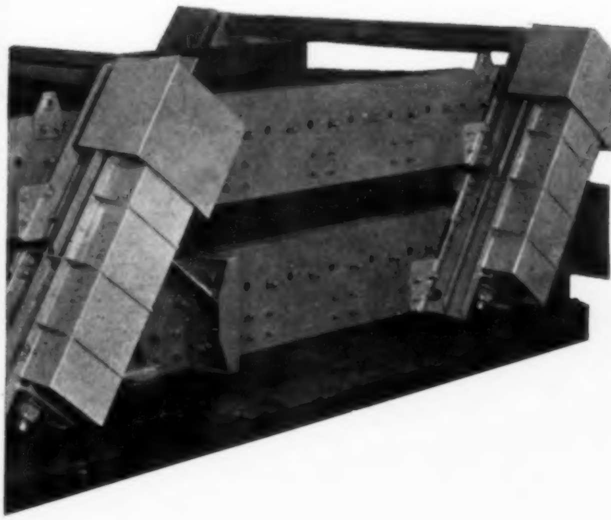
INDUSTRIAL HOSE • DESIGN, MANUFACTURE, ENGINEERING AND ERECTION OF COMPLETE BULK MATERIALS HANDLING SYSTEMS

"GLIDE RIDE" THE NEW MOVING SIDEWALK

HR **HEWITT**

STAMFORD,

SAVE POWER
Possible



nance," the new Hewitt-Robins hi-G Screen develops a controlled, extremely sharp vibrating action. This resonance is induced by a relatively small mechanical exciter producing powerful vibrations with added "kick" to separate materials according to size.

If you need larger screens—screens that operate on or near the horizontal and still screen at large openings—*screens with readily accessible lower decks for easy observation, spraypipe installation and quick cloth changes* . . . the hi-G Screen is your answer. For information about hi-G Screens and other Hewitt-Robins vibrating equipment, contact our nearest sales office or write to our offices in Stamford, Connecticut.

-ROBINS

CONNECTICUT

HEWITT-ROBINS VIBRATING EQUIPMENT FOR THE COAL MINING INDUSTRY

GYREX SCREENS. General-purpose, positive-stroke, 4-bearing screen with amazing versatility of application and an unsurpassed record for stamina in service.

STYLES M AND MS VIBREX SCREENS. Full-floating, unbalanced, pulley-type, 2-bearing screen. Offers sharp sizing of a wide variety of materials at low cost.

STYLE J VIBREX SCREENS. General-purpose screen applicable to a wide variety of screening operations. Wide range of sizes for suspended mounting.

STYLE HS HIGH-SPEED VIBREX. For fine screening applications (up to 100-mesh in some cases). Highly effective circle-throw screening action.

ELIPTEX SCREENS. Exclusive 3-way elliptical motion for sharpest sizing and most effective dewatering. Horizontal-operating flat screens.

CAR SHAKEOUTS. Both Heavy-Duty and General-Service units for unloading all sorts of materials from hopper cars faster, more efficiently and more economically.

VIBRATING FEEDERS. Fully mechanical vibrating feeder. Easy to install, operate and maintain. Extremely high capacities at very low power consumption.

SCREEN CLOTH. Wire cloth in a variety of sizes, weaves and materials for virtually every sizing, separating or screening operation.

FOR SERVICE AND INFORMATION
ON BELTING AND HOSE
CALL YOUR LOCAL HEWITT-ROBINS
INDUSTRIAL SUPPLY DISTRIBUTOR
LISTED IN THE "YELLOW PAGES"

Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

For lower production costs and faster haulage, use
Exide®-Ironclad® MINING BATTERIES

MINE LOCOMOTIVES, SHUTTLE CARS AND TRAMMERS use dependable Exide-Ironclad batteries to help speed up car changes, keep loaders busy and main line haulage moving rapidly. Their use results in more trips per shift, more production per man-hour with less cost per ton handled. Because an Exide-Ironclad has ample reserve power, full-shift operation of equipment is attained, with as much tonnage handled during the last hour of the shift as during the first. Lower costs for operation, maintenance and depreciation make Exide-Ironclad batteries your best motive power buy—AT ANY PRICE!

EXIDE-IRONCLAD MINING BATTERIES give you:

RAPID, ACCURATE HANDLING—their high power ability assures instant starting and rapid acceleration

UNIFORM RATE OF HAULAGE—their high maintained voltages provide mine equipment with uniform speed all day long

HIGH AVAILABILITY OF EQUIPMENT—Ironclad dependability prevents unscheduled down time

LOW OPERATING COSTS—because of their high electrical efficiency

LOW DEPRECIATION COSTS—because of their proved long service life

JOB-RATED EQUIPMENT—with their wide range of capacities and sizes for every task

SAFE HAULAGE—there are no hazards of fire, fumes, noise, power failure associated with Exide-Ironclads

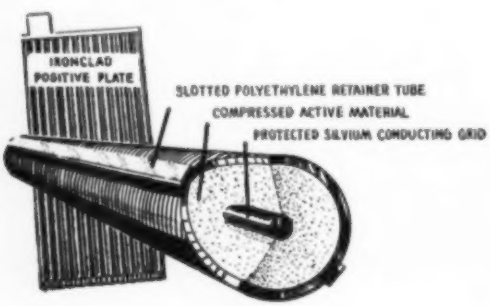
NEW, EXCLUSIVE EXIDE-IRONCLAD FEATURES

New Alloys—Silvium®, the latest development in grid alloys, prevents wear of the positive grid spines . . . assures higher sustained power for longer, useful working life.

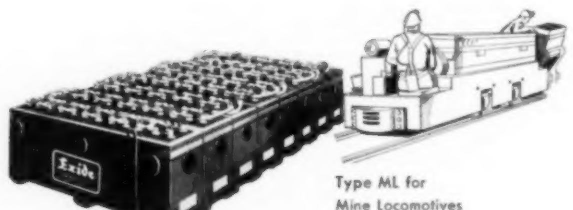
New Plastics—non-oxidizing polyethylene tubes improve battery performance and provide greater capacity in the same space.

Unique Positive Plates—the unique polyethylene slotted tubes inside an Ironclad keep active material in firm contact with the Silvium conducting grids of the positive plates . . . this grid protection lengthens the life of the battery. Slotted tubes expose more active material to the electrolyte . . . for greater power. Fine tube slots hold material in contact with grid longer. Result: The Ironclad battery's ability to furnish dependable power for a longer time—at lowest cost.

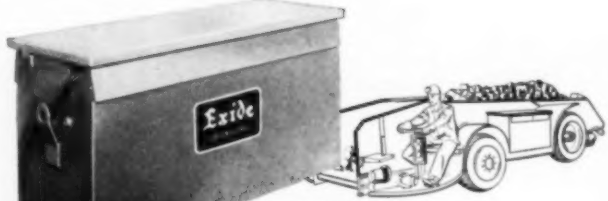
Other features include improved negative plates, new sealing compound, shock-proof molded container, unbreakable plastic vent plugs.



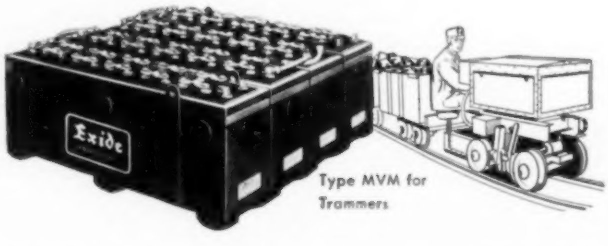
A FEW OF MANY EXIDE-IRONCLAD TYPES



Type ML for Mine Locomotives



Type TH for Shuttle Cars



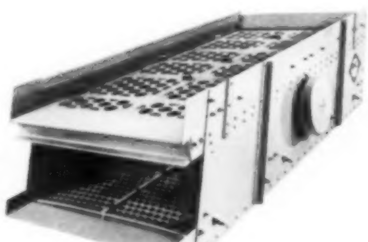
Type MVM for Trammers

Let Exide help solve your mining battery problems. Call the Exide sales office listed below. Write for specification sheets and Form 1982, a manual on maintaining motive power batteries.

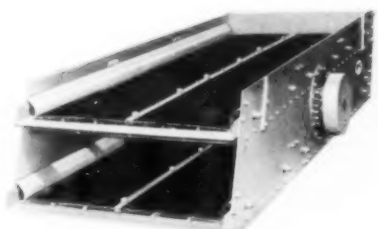
ATLANTA 10, GA.	1246 Allene Ave., S.W.
BOSTON 34, MASS.	100 Ashford Street
CHICAGO 9, ILL.	5335 S. Western Blvd.
CLEVELAND 14, OHIO	1014 Engineers Bldg.
DALLAS 1, TEXAS	2133 McKinney Avenue
DETROIT 4, MICH.	8051 W. Chicago Blvd.
KANSAS CITY 23, MO.	129 Belmont Blvd.
LOS ANGELES 15, CALIF.	1043 S. Grand Avenue
MINNEAPOLIS 3, MINN.	1750 Hennepin Avenue
NEW ORLEANS 12, LA.	406 Civic Center Bldg.
NEW YORK 36, N. Y.	25 West 43rd Street
PHILADELPHIA 4, PA.	101 N. 33rd Street
PITTSBURGH 16, PA.	1608 Potomac Avenue
ST. LOUIS 3, MO.	1218 Olive Street
SAN FRANCISCO 24, CALIF.	6150 Third Street
SEATTLE 4, WASH.	1919 Smith Tower Bldg.
WASHINGTON 6, D. C.	1819 "L" Street, N.W.

More complete information on Allis-Chalmers equipment for the coal industry can be obtained by writing for the various bulletins listed in this catalog or by contacting the Allis-Chalmers representative in your area.

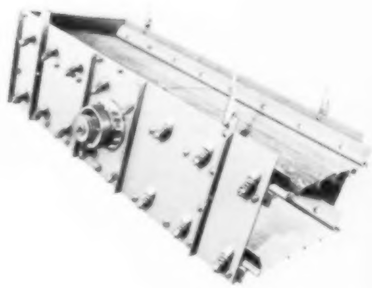
Allis-Chalmers is leading supplier of **VIBRATING SCREENS** for coal



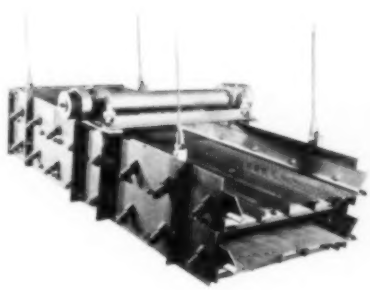
Model XH *Ripl-Flo* inclined screens have heavy steel construction and balanced two bearing mechanism. May be obtained with 1, 2, or 3 decks. Maximum feed size 24 inches. Send for Bulletin 07B6151.



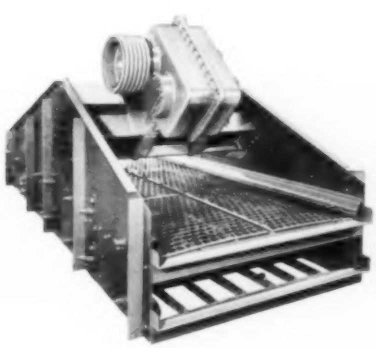
Model SH *Ripl-Flo* inclined screens have balanced two bearing mechanism and are built for a variety of applications . . . 1 to 4½ decks. Maximum feed size 8 inches. Send for Bulletin 07B6151.



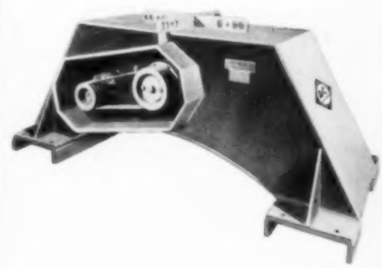
Model S *Ripl-Flo* inclined screens are low cost . . . have two bearing mechanism located between decks. May be obtained with 1, 2, or 3 decks. Maximum feed size 6 inches. Send for Bulletin 07B8229.



Model AVS *Aero-Vibe* inclined screens have two bearing mechanism located above the body . . . 1, 2, or 3 decks. Top screening efficiency at lowest cost. Maximum feed size 6 inches. Send for Bulletin 07B6099.



Low-Head horizontal screen operation saves headroom. Mechanism located above body . . . imparts a straight line motion to screen. Available with 1, 2, or 3 decks. Maximum feed size 8 inches. Send for Bulletin 07B6330.



For quick, safe unloading—Allis-Chalmers Car Shakers unload hopper bottom railway cars in minutes . . . big savings in manhours and demurrage costs. Eliminates necessity for men to enter cars. Motor and drive are within the shaker body, protected from weather. Fits all U. S. standard hopper bottom cars. Bulletin 07B7221.

ALLIS-CHALMERS

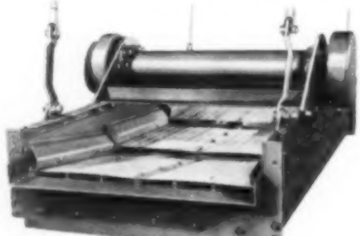
968 SOUTH 70th STREET • MILWAUKEE 1, WISCONSIN

25 C 6280J

vibrating screen SELECTION GUIDE for coal preparation plants

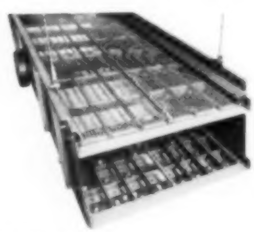
APPLICATION	MAX. FEED SIZE	APERTURE RANGE	SCREEN	COMMON SIZES
Sizing ROM Coal & Rock ahead of Crushers or Packing Tables	24 in.	3 to 10 in.	Model XH	4 x 10 to 6 x 16 ft.
Dry Sizing Raw Coal ahead of Cleaning Units	8 in. 6 in.	4 Mesh to ½ in.	Model SH **1** and **2** Model S	4 x 10 to 6 x 16 ft. 3 x 6 to 4 x 10 ft.
Wet Sizing Raw Coal ahead of Cleaning Units	8 in. 6 in. 5 in.	28 Mesh to ½ in. 28 Mesh to ½ in. 48 Mesh to ½ in.	Model SH **3** Model S *Low-Head* **3**	4 x 10 to 6 x 16 ft. 3 x 6 to 4 x 10 ft. 3 x 6 to 6 x 20 ft.
Sizing and Dewatering Coarse Coal after Cleaning Units	8 in. 5 in.	¼ to 4 in. ¼ to 3 in.	Model SH *Low-Head*	4 x 10 to 6 x 16 ft. 4 x 10 to 6 x 20 ft.
Wet Sizing Middlings after Cleaning Units	8 in. 6 in. 6 in.	¼ to 1½ in.	Model SH Model S Model AVS	4 x 10 to 6 x 16 ft. 3 x 6 to 4 x 10 ft. 3 x 6 to 4 x 10 ft.
Sizing Fine Coal after Dry Cleaning Units	1¼ in. 1¼ in.	28 Mesh to ⅛ in.	Model S Model AVS	3 x 6 to 4 x 10 ft. 3 x 6 to 4 x 10 ft.
Dewatering Refuse after Cleaning Units	8 in. 6 in. 5 in.	20 MM to ½ in.	Model SH Model AVS *Low-Head*	4 x 10 to 6 x 16 ft. 3 x 6 to 4 x 10 ft. 4 x 10 to 6 x 16 ft.
Media Recovery after Heavy Media Cleaning Units	8 in.	½ MM to 1½ MM	*Low-Head*	3 x 12 to 6 x 20 ft.
Dewatering Fine Coal after Cleaning Units	½ in.	⅛ MM to ½ MM	*Low-Head*	3 x 12 to 6 x 20 ft.
Sizing Washed and Crushed Coal	1½ in. 1½ in. 1½ in.	3/16 to ⅜ in.	Model SH Model S Model AVS	4 x 10 to 6 x 16 ft. 3 x 6 to 4 x 10 ft. 3 x 6 to 4 x 10 ft.
Dewatering Sludge—Solids Recovery	¼ in.	⅛ MM to 20 Mesh	*Low-Head* Model S Model AVS	3 x 6 to 6 x 16 ft. 3 x 6 to 4 x 10 ft. 3 x 6 to 4 x 10 ft.

1 special screen decks for preventing binding when sizing damp coal



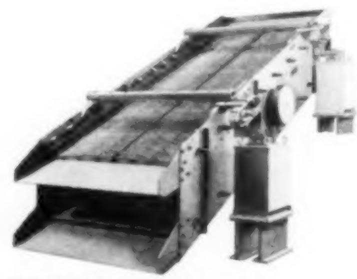
TRI-SLOPE Deck

For moist materials in ¼ x 0, ½ x 0 and ¼ x 0 sizes, and for making separations of ⅛ inch round, 10 and 14 mesh. Higher capacity than conventional decks. The steep slope at the feed end provides a rapid conveying rate. The center section is on a lesser slope to slow down the conveying rate. The discharge end section is on a still lesser slope to further reduce the rate of travel, for final accurate sizing. 07B6151.



***STA-KLEEN* Deck**

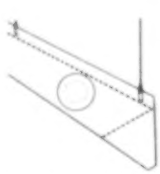
The deck consists essentially of a secondary deck located several inches below the screen cloth. It is divided into small compartments containing a patented oval rubber ball. The vibration of the screen causes the balls to bounce between the retaining deck and the screen cloth, imparting a secondary vibration to the cloth. This action dislodges particles that tend to clog apertures in the wire cloth. Bulletin 07B8354.



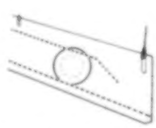
***THERMO-DECK* Heating Unit**

Eliminates blinding when using fine mesh cloth for screening fine moist materials by means of low voltage, high amperage resistance heating of cloth. Permits screen to operate continuously without shutting down to clear the screen, greatly increasing capacity. Heating is controlled by a tap changing switch on dry type transformer. Heat distribution to all parts of cloth is uniform. Cloth life is increased. Bulletin 07B7812.

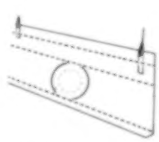
2 special screens for sizing raw coal
Bulletin 07B6151



Vibrating screen with reverse baffles at discharge end. Reverse angle baffles save headroom and permit use of smaller hopper.

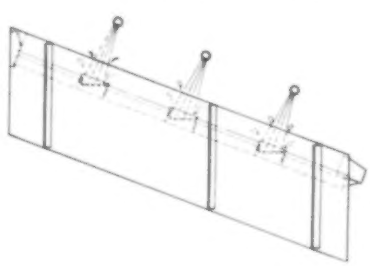


Double deck screen for reducing degradation when handling medium or soft structure coal. Eliminates top deck discharge spout . . . simplifies spouting . . . increases washer efficiency by removing maximum fines.



Multiple deck screens (different slope on each deck, depending on feed size and separation required) enable removing oversize lumps on top deck, egg or range size on second deck, nut size on bottom.

3 special screen decks for wet sizing raw coal



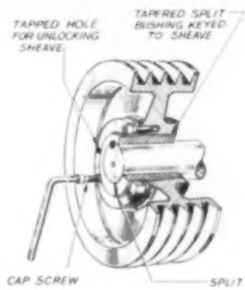
Pool washing screens utilize water sprays directed to washing pools in screen deck. Scrubbing process puts fines into suspension for passage through screen surface . . . increases screening capacity, saves water. Bulletin 07B8214.

Ripl-Flo, Low-Head, Aero-Vibe, Tri-Slope Sta-Kleen, and Thermo-Deck are Allis-Chalmers trademarks.

A DRIVE FOR EVERY MACHINE

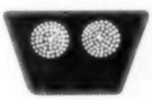
***Texrope*—greatest name in V-belt power transmission—is the registered trademark of Allis-Chalmers, originator and pioneer of multiple V-belt drives.**

Ask for Bulletin 20B6051, "Handy Guide to Selection of *Texrope* Drive Equipment"; it tells the complete *Texrope* Drive story . . . V-belts . . . sheaves . . . and how to figure a *Texrope* drive.



TEXROPE V-BELTS

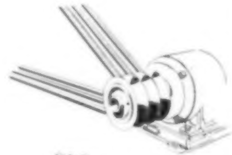
Famous patented grommet construction provides longer life than ordinary V-belts. Made with straight sides for greater grip. Types for all operating conditions: heat-resisting; oil-resisting; static-resisting and special High Capacity. Also available: *Texrope* wide range V-belts for use with wide range *Vari-Pitch* sheaves and *Vari-Pitch* Speed Changers.



MAGIC-GRIP SHEAVES

The *Magic-Grip* cast iron sheave is designed for fast, easy mounting and demounting. Construction is simple, foolproof. Sheave can be installed or removed in shortest possible time. Cuts *maintenance* costs—reduces "down" time to minimum. It automatically adjusts itself to slightly oversize or undersize shafts. Positive clamp fit on shaft means no weaving—no vibration. There is no back lash—no extra play. Sheave can be mounted closer to motor or machine—reducing strain and stress. Result: bearing pressure *eased*—bearing life *increased*.

Entire sheave is smoothly finished, firmly fastened. No protruding bolts or set screws. Constant tension on cap screws means they won't work loose. Stock sizes for drives up to 150 hp. Larger sizes available on order.



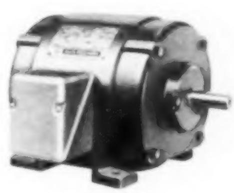
VARI-PITCH SHEAVES AND SPEED CHANGERS

VARI-PITCH SHEAVES are available in two types; Standard Range for A, B, C, D or E belts—capacities from 1 to 300 hp—speed variations up to 38%. Wide Range for Q and R belts—capacities from 1½ to 40 hp—speed variations up to 100%. Both types designed with stationary or motion control features—Stationary Control for infrequent changes when sheave is stopped; Motion Control for repeated speed changes while sheave is in motion. Bulletin 20B6082.

Vari-Pitch Speed Changers furnish 3¼ to 1 speed ratio in one compact, enclosed unit. Adjustable while in motion. Combines two wide range, worm gear-adjusted sheaves. Manual or pushbutton control. Bulletin 20B6013.

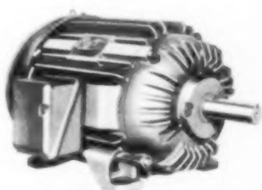
MOTORS FOR EVERY DRIVE

Allis-Chalmers builds a *complete* line of polyphase squirrel cage, wound rotor, synchronous, and direct current motors with electrical and mechanical modifications to meet *any application*. Ask for Bulletin 51B6052, "Handy Guide for Quick Selection of Electric Motors"; it furnishes you with enough facts on Allis-Chalmers motors to enable you to select the type which meets your required electrical and mechanical specifications. The next time you need an electric motor, contact your nearby Allis-Chalmers representative.



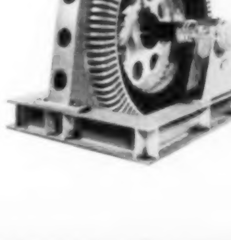
DRIP-PROOF

Small, tough, general purpose squirrel cage motors. All-around protection of inner parts. ½ to 200 hp and up. Also in splash-proof types. Bulletins 51B6210 and 51B7693.



ENCLOSED FAN-COOLED

Protected from dust, grit, vapor, gases. Cooling air circulated around exterior. ½ to 100 hp. Bulletin 51B7225. Also in new tube cooled type to 3000 hp. (51B7150).



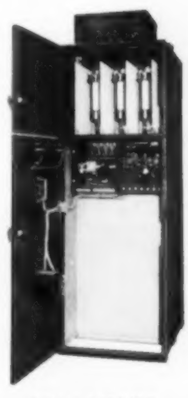
SYNCHRONOUS

High torque motors of constant speed, available in ratings of 40 hp and larger. End shield bearing types, Bulletin 05R-8183; pedestal bearing types, 05B7648, 05B7649; engine type 05B8008.

CONTROL FOR EVERY MOTOR

Allis-Chalmers makes a line of starters to meet practically all motor control needs. Count on this wide range of starters, backed by industry-wide application engineering experience, for the answer to your control needs. Ask for Bulletin 14B7733.

Bulletin 14B7132



Bulletin 14B6410

WOUND ROTOR

For adjustable varying speed service. High starting torque, low starting current. Bulletins 51B6052 and 05R8183.

LARGE INDUCTION

Drip-proof or splash-proof. 60 hp at 300 rpm to 2000 hp at 1800 rpm. Bulletin 05B7542. Ped. bearing types, 05B7771.

Texrope, Vari-Pitch, and Magic-Grip are Allis-Chalmers trademarks.

POWER AND ELECTRICAL EQUIPMENT

As a leading manufacturer of both steam and hydraulic power plant equipment, Allis-Chalmers is in a position to fill your complete requirements for turbines, generators, condensers, pumps, control equipment, etc.

And for power distribution, A-C has transformers, motor-generators, converters, rectifiers, metal-clad switchgear, switchboards, indoor and outdoor circuit breakers, etc.

TRANSFORMERS

From the largest power transformers to instrument and metering transformers in a wide range of types and ratings. Dry-type transformers from 3 to 12,000 kva for installation right at load centers. Sealed dry-type available for mine use. Transformers also available with *Chlorextol* non-inflammable liquid for mounting indoors or on roofs.

SWITCHGEAR

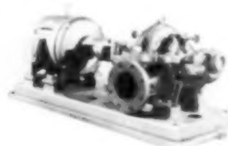
High and low voltage metal-clad and metal enclosed switchgear in all standard ratings to suit your particular requirements. Breakers for HV switchgear can be either oil or magnetic air types. LV switchgear uses either manually or electrically operated air breakers. Weatherproof switchgear is available for outdoor installation. Switchboards built to suit, in standard or duplex types.

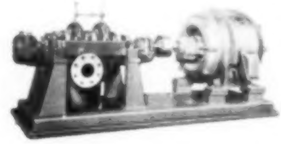
UNIT SUBSTATIONS

Completely factory built, unit substations can be installed indoors or out to provide power where you want it . . . to reduce cable costs and line losses . . . to provide better regulation. A-C substations can be built with any combination of HV and LV switchgear and oil, air or *Chlorextol* liquid cooled transformers to suit application. They can be equipped with rectifiers for reliable dc supply. Bulletin 11B6285 for load center units and 11B6935 for outdoor multi-circuit units.

CENTRIFUGAL PUMPS

More than 60 years' experience in designing and building centrifugal pumps goes to work for you when you specify Allis-Chalmers. This engineering background is your assurance of the *right* pump for your job! Whether your application calls for a single-stage or multi-stage pump, a pump to handle clear liquid, corrosive or abrasive liquids, or liquids containing high percentages of suspended solids, contact A-C for the *one* pump that will meet your particular requirements. Ask for "Handy Guide to Centrifugal Pumps," Bulletin 52B6059, for the story on the complete A-C line.





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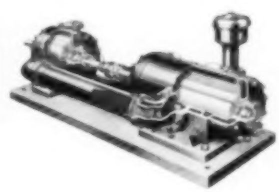

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THE 1956 . . .

Coal Age Mining Guidebook

What It Is

COMBINING THE FUNDAMENTALS with the latest in operating techniques and equipment, this 1956 edition of the *Coal Age* Mining Guidebook is designed for continuing reference in checking, developing and improving mining practices, and in purchasing equipment, materials and services. Extensively revised and incorporating the latest in methods, equipment and materials, this second in a continuing annual series of Guidebooks is designed to provide these three services:

1. **Practical, down-to-earth, up-to-date and continuously useful data** on basic principles, modern practice, and modern equipment and materials for cutting costs, raising product quality and promoting safety in both deep and strip mining.

2. **Special data on equipment,** materials and services for modern mining. In this section, the manufacturers present key information on the products, materials and services they offer the coal-mining industry.

3. **Where to buy equipment, materials and services.** Arranged by products and including trade names, this buying directory is designed to facilitate the location and purchase of equipment, materials and services by conveniently arranged listings of who offers what and where they can be found.

Who It's For

THE 1956 COAL AGE MINING GUIDEBOOK AND BUYING DIRECTORY is designed for all men—organization heads, operating officials, engineers and designers, and electrical, mechanical, preparation, maintenance and safety men—involved in coal production, preparation, safety and related activities, including the purchase and use of equipment, materials and services.

Face foremen interested in improving face haulage, as an example, will find a discussion of basic principles and modern practice under "Transportation" in the Deep-Mining Guidebook. Organization heads, operating officials and maintenance men, deep and strip, interested in improving their maintenance setup will find a separate Guidebook devoted to this subject. And the what, where and how of machine application—and the results that can be attained—run through the entire Mining Guidebook, with the Buying Directory and manufacturers' pages handy as a reference in purchases—not only of equipment but also of materials and services.

How to Use It

CHECKING MINING PRINCIPLES AND PRACTICES—What the six main divisions of the Mining Guidebook are and where they appear is shown in the general index on p 3. For added convenience, detailed indexes on the material appearing in each division precede each such division and permit rapid locating of the material on specific topics, such as, pitch operation in deep mining, haulage in strip mining, dewatering and drying in preparation, and so on.

BUYING EQUIPMENT, SERVICES AND MATERIALS—For locating the makers of, for example, wire rope, vibrating screens and lubricants, check the appropriate product classifications in the Buying Directory, beginning on p 221, and consult the data provided by the manufacturers in the advertising section. EXTRA in 1956—a list of sales offices and representatives of advertisers in this issue by states. See the Advertising Index p 285 for the office nearest you.

BEST PORTAL LOCATION and best cleaning-plant location may be at separate points, as illustration above indicates. Portal was designed for truck haulage to the preparation plant. The slope was double-decked to reduce width and thus make it more stable in uncertain ground.

Opening and Development

Portal Location

LOCATION OF THE MAIN OPENING and main plant for the lowest over-all cost requires study and balancing of many diverse factors. Normally, if a shaft or slope is required, and the coal is level or only slightly pitching, the shaft or slope is placed as nearly in the center as possible. This keeps haulage and travel distances to the minimum over the life of the property. Normally, also, other things being equal, the opening should be made to permit hauling loads on the level or downgrade as far as possible if the dip of the coal is over, say, 1½ or 2%.

Other factors having possible weight in portal location include:

1. Space for parking as many cars as may be necessary, preferably on level or nearly level ground for easy movement when snow is encountered.
2. Space for coal storage either at the time the plant is built or at some later date. Storage facilities for as much as a week's run or more of raw or prepared coal are not uncommon nowadays, and even where capacities are more moded the trend is toward providing bin or ground space for a half to a full day's tonnage.
3. Space for expansion of the plant if desired at some future date, or for the addition of some type of equipment that might come into use at some future date.
4. Availability of water for plant use if washing is done or contemplated.
5. Space for sludge ponds and clarification equipment if such equipment is installed when the plant is built. If not installed at that time, it should be contemplated that it might become necessary at some future date.

All of the preceding factors might dictate a longer haul or a deeper shaft or slope to permit a more economical plant location from all standpoints, including excavation, grading and foundations. And since a surface haul normally is cheaper than underground, the availability of such a haul might in itself warrant a change from dead property center for the portal. Where an area is to be worked from several portals a surface haul or hauls to a central preparation point is the natural thing.

Location of the preparation plant completely away from the mine is a further possibility. In fact, it could be located in a consuming area or at some convenient way point where water, space and other necessities were plentiful, along with a wider choice of transportation facilities; for example, a combination of water and rail.

However, moving the preparation plant away still leaves the problem of shops, parting areas and other facilities. A major question is the opening or openings

for men and supplies. Unless the terrain makes it impossible or prohibitive in cost, the need for keeping travel time to a minimum has led to widespread sinking of auxiliary slopes or the opening of auxiliary portals at intervals as the mine develops to keep down underground distances for men and supplies.

Sinking Rock Slopes

THE FOLLOWING EQUIPMENT normally will be required in sinking slopes in rock where the mining company prefers to do the work itself:

Shovel, dragline or bulldozer for preliminary excavation if the material is fairly deep and soft. A bulldozer normally is required in any event for miscellaneous earth moving and excavation, and for spreading refuse. These and certain other units frequently can be rented, rather than purchased.

Storage bin on surface unless muck is dumped directly to trucks. Normally, a bin will pay off by preventing delays and interruptions.

Refuse-disposal and service trucks.

Electrical substation or engine-generator plant.

Field shop.

Field supply house.

Field office, locker and change facilities. These, as well as the field shop and supply house, may all be in the same structure or separate buildings may be employed, including semiportable or prefabricated. Though it is not usual practice, the permanent buildings may be erected in advance of portal development.

Fan or tubing blower, with duct or tubing.

Water supply for wet drilling, sprinkling and general use.

Pumping equipment, if necessary, for dewatering slope.

Concrete-mixing facilities, unless ready-mix is available at a desirable price. As an alternate to at least part of the concrete work, steel liner plate may be employed. Concreting or lining normally is done only for the softer section of material at the top of the slope. Below that, the natural-rock ribs normally will stand and the top can be taken care of by bolting or conventional timbering. Bolting also may be employed to keep ribs from sloughing or caving. Spraying with a sand-cement mixture or wire mesh also may be done to prevent spalling and disintegration as a result of temperature and moisture changes, or the ribs may be coated with roof-sealing compounds.

The usual belt slope also is employed for handling men and supplies. Consequently, the belt normally is placed to one side with the track at the other and the stairs in the center. However, all other arrangements have been employed, including increasing the height of the slope and putting the belt on crossbeams over the top of the supply track and stairs. The belt or supply track may be separated from the other facilities in the slope by guard rails, low concrete curbs or walls, or a center line of roof supports. For easy walking, one mine built experimental steps and had men try them. As a result, the stairs were built with a 6-in rise and a 24-in tread.

Because of the length of time required in sinking the longer slopes, and also because of the long tubing runs that would be required, it may become desirable to erect a center partition, thus establishing two compartments for ventilation. Rather than use shiplap or standard brattice lumber, thin-section plywood in standard-sized sheets offers economies in both purchase cost and cost of installation.

Methods of handling heavy inflows of water from soft

Where to Find It in . . .

The Deep-Mining Guidebook

HELLDIVER (left) facilitates loading in sinking coal slopes. The big drill (right) is one tool for speeding up the raising of parallel airways, drilling as many openings side by side as are required for the necessary air flow.

water-bearing measures including standard grouting and also the use of gel-type chemicals which solidify after pressure injection and render the material impervious.

Sinking Systems

Depending upon the mucking system adopted, equipment normally employed in slope sinking is as follows:

HAND MUCKING

Hoist on surface (50 to 75 hp, single drum, in most instances; same hoist may be continued in service to handle supply cars in regular operation).

Muck car.

Air compressor.

Drilling equipment. In at least one instance, a slope has been sunk using standard post-mounted electric coal augers—reportedly at a substantial saving. Normally, however, air is required in going through rock. Hand-held or other unmounted drills may be used, but their footage is lower. At the other extreme, a track-mounted jumbo—one or two drill mounts—may be employed for maximum drilling speed in slopes up to 45 to 50 deg, even though it may be necessary to pull it out between rounds or provide special parking facilities near the face. Between the two extremes are column- or bar-mounted drifters or sinkers, as well as the newer air-leg or jack-leg units.

Roof-bolting equipment rounds out the list, unless conventional supports are employed.

Minimum crew for such a sinking job probably would be approximately as follows, these men also taking care of installation of lining and roof support when not engaged in regular duties: drilling shift—two or three drillers, mechanic or electrician, and a handyman (hoisting, supplies, etc.); mucking shift—two or three muckers, hoistman, truck driver and dozer operator. It sometimes is possible for one man to take care of all hoisting and refuse disposal, although normally more than one are necessary, in which event the truck driver, dozer operator and any others employed normally will handle miscellaneous duties. And, as noted, all men will be available for installing lining, supports and the like. On this basis, average advance in a 7x15-ft slope would be 3 to 4 ft per shift—perhaps more with favorable conditions or jumbo or other high-speed drilling.

MACHINE MUCKING

Where muck is loaded mechanically, the equipment setup may be as follows:

Hoist.

Muck car or conveyor system. The latter may be chain equipment only, or a chain unit may be used between a belt unit, which eventually will become the slope conveyor, and the face.

Standard coal-loading machine, or rock loader of the standard, overshot or slusher type.

Air compressor.

Drilling equipment—substantially the same as with hand mucking. However, where crawler loaders are used and consequently cannot be hoisted out readily it may be difficult to use jumbos because of interference.

Roof-bolting equipment (unless conventional support is employed).

Pitch usually dictates to a considerable extent the type of loader that may be employed. Standard or conventional loading machines usually are limited to 20 deg or less, though the overshot unit of the track-mounted type can operate on somewhat heavier inclines. With certain types of slushers, mucking can be done at up to 50 deg, other conditions being favorable.

The "helldiver," though employed mostly in coal (see following section on "Sinking Coal Slopes"), also may be adapted to sinking in rock at pitches up to 50 to 60 deg. Incidentally, where conveyors are employed to move muck the practical limits are about as follows: belt 17 to 20 deg; standard chain 30 to 35 deg; special high-flight chain conveyor designed for hoisting work, 45 to 50 deg. Where the slope is long, chains must be used in tandem, since the practical working length usually is not over 300 ft, particularly if operated up hill.

With slightly different duties, crews for machine mucking can be about the same in number as with hand mucking. Rate of sinking in a 7x15-ft slope, including lining and support, usually ranges from 5 to 10 ft per shift.

DRILLING FIRST to outline shaft where cover is thin speeds sinking and protects walls against shooting, reducing need for lining.

BIG CORING-TYPE DRILL sinks small air and man shafts quickly and economically.

CONTINUOUS SINKING

In addition to growing effectiveness in coal, continuous miners also are proving quite effective in slope sinking and other rock work where conditions are not too difficult. Equipment usually employed is as follows:

Sinking machine. To date, these have been of the boring type and have been used only in sinking belt slopes on inclinations of around 20 deg or less.

Conveyor system (muck car an alternate).

Roof-bolting equipment (unless conventional support is employed).

The use of continuous-type mining-and-loading machines for slope sinking is a relatively new development. Results so far indicate that advances of 10 to 30 ft per shift are possible, depending upon the hardness of the rock. Since hard sandstone, limestone and the like still are tough for mining-and-loading machines, they normally should be considered only where shales and other soft material predominate.

Sinking Coal Slopes

EXCEPT THAT THE PRODUCT normally is not dumped to refuse, sinking slopes in coal is substantially similar in practice to sinking in rock. Equipment normally is of the coal type, and aside from loaders and the like, may include coal cutters unless pitch, interference or other conditions prevent their use. Except for certain anthracite applications and some exceptions in bituminous mines, electric coal augers are standard for drilling, and the cycle corresponds with the cycle in a room face.

Cars or skips may be loaded by hand up to 75 to 80 deg. Conveyors may be loaded by hand up the limit of 45 to 50 deg for the special high-flight hoisting type. With loading machines, the usual limit for conveyors is around 20 deg. The maximum nose-down pitch for continuous miners still is to be determined, but they are promising candidates up to 15 to 20 deg.

The "helldiver" is one of the special machines for fast loading in slopes up to 50 deg. It consists of a scoop on the front end of a weighted truck (for construction details, see *Coal Age*, May, 1951, p 100). With the scoop down, the helldiver is dropped into the loose coal at the face. In the hoisting phase of the cycle, the scoop is raised automatically and the entire unit is pulled to the dumping point—normally a hopper under the track with an opening between the rails. The hopper is above the haulage level and false rails permit hoisting over the level track. Coal is transferred from the hopper to cars on the level road by an elevating conveyor.

In 4½ ft coal, places 10 ft wide, with crews of 3 to 4 men, average production with the helldiver is one 7-ft-deep cut per shift, including installation of permanent roof supports and other necessary operations. With loading machines in slopes under 17 or 18 deg, 5-ft coal or thicker, the usual advance is 1 to 3 cuts per shift, with the higher figures possible as a rule only where there is little need for installing permanent supports. Advance with hand loading, whether into cars or conveyors, seldom is over one cut per shift with a 3- or 4-man crew.

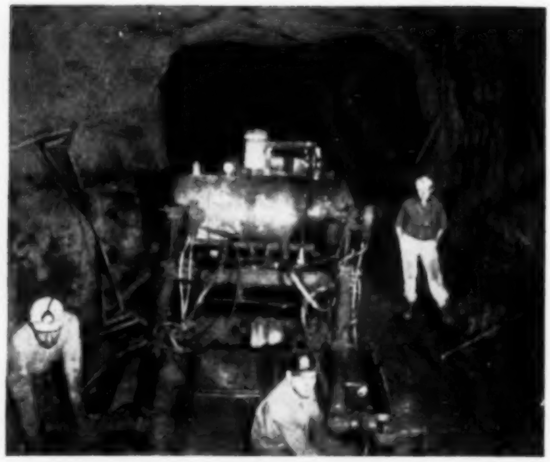
Raising Slopes and Airways

AS IN SINKING, raising of slopes and airways under, say, 20 deg in either coal or rock can be done with machine mucking or loading, or with hand loading. Although equipment can be installed to take cars to the face, the preferable transportation medium is the conveyor up the point where the material will run on sheet iron, which is around 30 deg. At around 35 to 40 deg, coal will begin to run on the bottom rock, and above approximately 45 deg, checks or batteries are required.

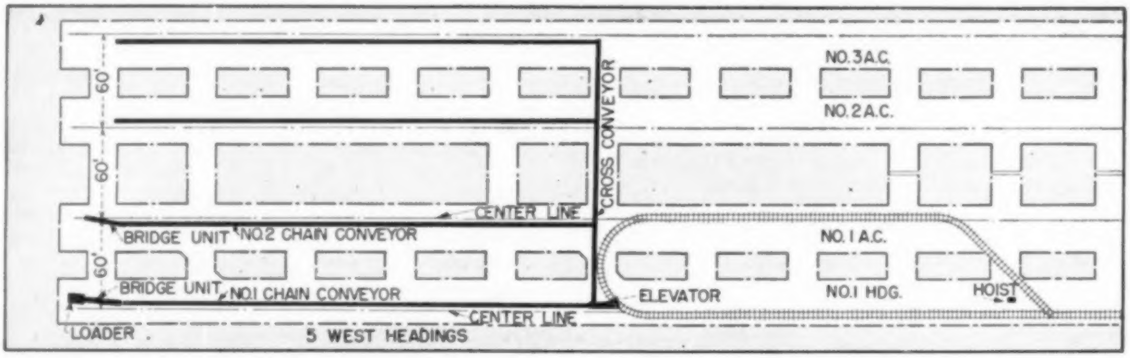
Where raising is done in coal, continuous miners have been successfully used in pitches up to 15 deg or better. In one instance, using pickup loaders, shuttle cars and cross-measure shakers for gathering, six airways were driven 1,500 ft up pitch to the outcrop by ripper-type continuous units with a substantial saving in cost over other methods. Maximum pitch encountered was 12½ deg.

In addition to raising parallel airways with conventional equipment operated from crosscuts off the main slope, big drills also have been used. At one mine (*Coal*

MACHINES SPEED DEVELOPMENT AND CUT COST. Here, air-powered crawler-mounted loader mucks into bucket in sinking air and man shaft.



DOUBLE-ARMED TRACKMOUNTED JUMBO on wheeled trucks speeds drilling and reduces cost of rock tunneling or heavy brushing.



BRIDGE-CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.

Age, May, 1951, p 100) such a drilling unit is fitted with a 42-in head, and one, two or three holes are drilled up the pitch to achieve the desired airway area. Drilling is done from crosscuts at the necessary intervals.

Shaft Sinking

TYPE OF SHAFT determines to some extent the method of sinking. Unless shafts are required rather frequently better results usually can be achieved by contracting their sinking, especially if they are large and deep, rather than by purchasing equipment and creating a staff of specialists. Surface facilities and sinking equipment, except for mucking, are substantially the same as in slope sinking (see pp 19-21). Lining materials, where required, include sprayed sand-cement and corrugated liner plates for circular openings, in addition to the standard timber, brick or concrete lining.

Muck may be loaded into a standard sinking bucket by hand, though in a multicompartment shaft where a heavy cage can be used in one compartment, new positive-action mucking machines mounted on the cage bottom may be employed in loading the buckets. (See May 1955, *Engineering and Mining Journal*, p 82, for example.) Where the depth is not too great, mucking may be done by a standard crawler-mounted clamshell operating from the surface. And if access to the bottom of the shaft is possible through openings that already exist or can be driven, the muck can be dropped through a pilot drill hole into mine cars below.

A new technique in sinking relatively shallow shafts—under 150 to 200 ft—which may also find application in even deeper openings, is outlining the shaft by 6-in drill holes on centers of 18 in, using either a strip-type overburden drill or a standard borehole machine (*Coal Age*, April, 1955, p 74). Then the same drill puts down inner holes as required for shooting. Mucking is done by a crawler-mounted clamshell. In addition to a high rate of sinking (9½ ft per 7¼-hr shift with one 16-ft-diameter shaft), the walls are protected from shock, need not be scaled in sinking, and stand well without lining after the shaft is completed. Mucking is done without men in the shaft, except for cleanup.

Drilling is finding increasing application as a means of sinking shafts for air and emergency purposes, as well as for men and materials. These drills operate on the coring principle, with the latest employing dry oil-well-type cutters on the drilling edges. The entire drilling unit is lowered into the hole, along with the operator, and is hoisted to permit removing core sections. Its initial assignment (*Coal Age*, January, 1955, p 80) was

LOWER COST is among advantages of exploiting outcrop with underground development. Shovel and bulldozer develop for auger mining here.

drilling a 75-in hole 467-ft for a man-shaft. The hoisting equipment for this shaft, incidentally, is of the so-called friction type without a rope drum or drums.

Rock Tunneling

IN STARTING a rock tunnel from the outside, it may be possible, as in slope sinking, to use a dragline or some other type of excavator to go through the soft material. At some mines, this initial cut has been left open, with the sides stabilized by planting special ground covers. Spraying with a standard sand-cement mixture also has been successfully done to stabilize cut slopes. At others, a concrete section has been installed, as in slopes, and covered with excavated material. Cut-and-cover has the advantage that the material need not be hauled away, compensating in part for the cost of the lining.

Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring only once in a great while. The coal equipment, of course, includes loading machines and shuttle cars and conveyors. Where much rock tunneling is required, however, special rock facilities normally are employed. Rock machines include loaders similar to coal machines but designed for rock loading; also overshot-type loaders and slushers or scrapers of the 2- or 3-drum type, the latter providing a greater degree of flexibility in covering the entire face. The machines may load into rail cars, regular or rock-type shuttle cars or conveyors.

Drilling normally requires pneumatic equipment and compressors. Drills vary from hand-held through air-leg, post-mounted and bar-mounted types to mobile single-arm and double-arm jumbos. Where considerable tunneling is done and other conditions do not militate against them, the mounted jumbo normally provides the greatest capacity and the lowest cost in drilling.

In one 8 x 12-ft tunnel using a duckbill for loading, a crew for one shift was made up of a boss, three heading men and one loading-end man. Average performance was two rounds 6 ft deep every three shifts. Drilling time (two drifters on a bar) averaged 3½ hr per round, and loading time, 6½ hr, including temporary timbering, advancing conveyor, etc.

In one 14 x 8-ft tunnel driven with a regular rock-loading machine, average performance was two 10-ft cuts per day of four 6-hr shifts. A four-man drilling and charging crew using two post-mounted drifters normally drilled and charged 26 holes in less than a shift. The cut then was completely mucked on the next shift by a 3-man crew. A ditch 5 ft at the top, 3 ft at the bottom and 3 ft deep was mucked by a hoe-type scraper working behind the rock loader.

In an 8 x 12-ft tunnel with 2 x 1-ft ditch on one side, drilling was done by a trackmounted double-arm jumbo and a car transfer was installed to facilitate switching cars behind the rock loader. The jumbo crew consisted of four men and the loading crew of 3 men. Average advance was 1 ft per hour. At this operation two or more places permitted shifting the machines back and forth.

Mine Projection

FULL-RETREAT MINING means mining from the boundary back to the bottom or portal, is the ideal system, with exceptions so few as to be negligible. Before the advent of the mining-and-loading machine, or continuous miner, however, the rate of entry advance was relatively slow, even with the best of machines and systems. Therefore, complete adherence to the principle meant a rather lengthy development period during which coal production was relatively small. As a result, a number of compromises were employed.

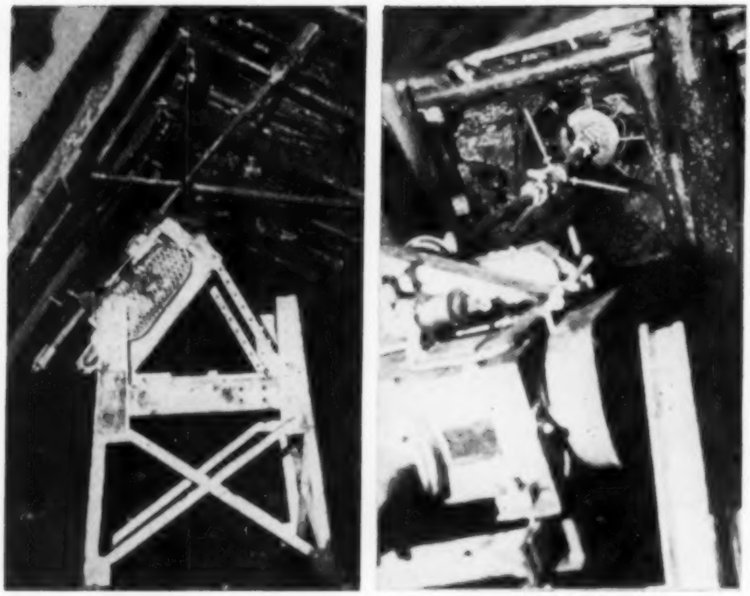
One compromise providing results frequently as good as full retreat is advance on one side of the mine or working territory and retreat on the other to complete extraction. The basic principle is followed completely if full retreat is practiced in the individual working sections, though here again rooms may be mined on one side of a production entry on the advance, and on the other side on the retreat.

Other methods of providing coal while entries are being driven for a full or approximately full retreat system include setting off a special territory well protected by barriers near the bottom or portal, which can be mined, caved and abandoned without risk of affecting the permanent facilities. And where the coal outcrops along a hillside, quick production can be attained by moving in a shovel and stripping the outcrop, not only recovering coal in the stripping operation but also opening up the vein for augering or for deeper recovery by standard underground equipment, such as, a panel belt with loaders or continuous miners, shuttle cars and auxiliaries. If heavy rock or some other handicap makes true stripping undesirable, but conditions are such that benching is feasible and economical, augering or paneling still may be not only a help in development but also a source of considerable low-cost tonnage.

With the development of the mining-and-loading machine, the problem of going to full or near-full retreat in the thicker seams—and eventually in the thinner—is materially simplified. This results from the fact that the machine's rate of production is the same or almost the same as when working in rooms. Therefore, if the plan is to use four machines two shifts, they can all be concentrated in driving headings, providing full or nearly full production from the time of breaking away from the bottom or portal.

Contour Development

In mining hilltops and knobs, the panel belt and other modern equipment permits economical recovery at a high rate of production, whereas such areas frequently were impossible to operate when everything had to be done underground. Now, the outcrop is opened by a



BORED CROSCUTS in pitches cost less and require simple, inexpensive stoppings. New lightweight boring unit is designed with hoist in upper opening to pull big bits through pilot hole.

bulldozer or shovel—the latter normally is required to make the necessary width of bench—and the coal is mined by all-conveyor units of the hand-loaded or self-loading types, or by loading machines and shuttle cars feeding to mother conveyors or panel belts. The belts in turn may feed to mine cars on track laid on the bench. As an alternative, especially where it is desired to work sections large enough to warrant a mainline belt, the coal may be discharged to a semiportable storage bin for trucking to the main plant. By erecting the bins in multiple, it is possible to store the full output of a second shift, for example, eliminating the need for trucks and preparation facilities on that shift.

In addition to conventional equipment, contour development and production may become one of the special provinces of the remotely controlled mining-and-loading machine. Remotely controlled boring-type equipment has been or is operating at distances up to 1,000 ft from the outcrop with both articulated conveyors and the extensible belt.

Section Setups

One question in setting up a mining section is whether to aim for complete isolation: in other words, a panel completely enclosed by pillars with no openings except for the panel headings. Considerations favoring complete closing of panels include: liability of the coal to spontaneous combustion, and the possibility of breaks in the roof to water-bearing strata. Closed panels facilitate sealing and damming where fires or water breaks occur. The closed panel also facilitates sealing to comply with legislation or the rulings of inspection departments.

Pillaring within a closed panel, however, is more difficult unless conditions are more favorable than those usually encountered. Therefore pillars frequently are left in place where panels are closed, though a number of operations recover them quite successfully.

Among the benefits of the panel system, whether completely closed or open, is ease in establishing splits for each individual working section. The panel system also lends itself somewhat better to the establishment of bleeder headings—a growing practice where gas emission is heavy and even where not for a general improvement in conditions. A major advantage is the fact that the working places are always in fresh air since the travel is one way over the active workings and gob areas to bleeder openings. An added benefit of such openings is the fact that they provide additional escape routes in case of disaster.

Bleeder openings may be established in a number of ways. Examples are:

1. In room work on the advance, driving a place from the face of the first room, when it reaches full depth, back to the return of the main or cross entry from which the room entry was turned.
2. Driving a special bleeder entry and escapeway at the tops of room panels, or between panels turned toward each other, and cutting into it by extending the room entries, or by driving over to the bleeder from the faces of the first rooms or rooms to be completed.
3. Extending the first rooms to be completed to cut into a bleeder opening made by leaving the pillars in at the faces of the rooms in the preceding panel. As each room is cut into the old panel, the old pillar is included in the extraction routine to complete recovery.

These and other methods of establishing bleeders are illustrated in plans on pp 33, 36, 37, 38 and 65 of this Deep-Mining Guidebook.

Pillaring Practice

A second question in setting up a mining plan is whether to take pillars or leave them. Where the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. In contrast, pillars also are left in some thick-coal areas because of bad top. Basically, however, taking pillars, unless some special conditions prevent, is desirable to get full return on the necessary expenditures for entry-driving and other development operations. Leaving a third of the coal, for example, means driving, supporting, equipping and maintaining a third more room entries for a given tonnage.

A subsidiary question is pillar size and shape. As a general rule, these are set by experience with the top, bottom and other natural conditions in the region, with another factor whether or not recovery is immediate. Aside from the weight question, square blocks and a standard width of opening everywhere result in uniform pillaring conditions all the time, thus tending to raise efficiency. Angle driving, yielding "diamond" pillars, substitutes, as a rule, 60-deg turns for 90. Both mine cars and shuttle cars are favored by these gentler turns, but ease of operation in other directions may dictate retention of the 90-deg principle.

Changes in equipment type also influence practice in sizing pillars. Thin pillars between rooms, for example, facilitate crosscutting and pillar extraction with bridge conveyors. Otherwise, after the reach of the bridge unit is exhausted, an auxiliary cross conveyor and drive would be necessary. Even without special equipment, thin pillars may be desirable for several reasons. To get maximum extraction in first mining, as an example, one operator reduces pillars to two-cut thickness. The final recovery step is slabbing one cut off the pillar and leaving the remainder.

Entry Driving

NUMBER OF OPENINGS becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number to two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up for rock tunnels underneath the vein, though the airway still is made in the coal as a rule, with connections for ventilation and mining through rock chutes. In lighter-pitch coal, conditions are more favorable to increasing the number of openings, though the general practice still is to keep the number as close to two as possible.

Among the factors involved in establishing the number of headings for an entry in flat-coal mining is airway area. In the thinner seams, especially if the air volume is expected to be large, driving additional openings to keep down velocity yields substantial savings throughout the life of the mine. But even after all the necessary openings for haulage, ventilation and man travel have been provided, it still may be desirable to increase the number. This is especially true with loading machines, and to a lesser extent with certain other equipment. The goal in increasing the number of headings is to make development work as near like room work as possible, which means the lowest cost, aside from a higher tonnage from the equipment involved. And since this makes development and room work nearly alike, management is relieved of a large part of the complications involved in scheduling development to provide production territories.

The continuous miner and the bridge conveyor, among other new devices, are, however, reducing the need for increasing number of headings for the sake of lowest face cost. A loader in two places equipped with bridge conveyors, for example, often can achieve higher tons per machine and per man, and thus a lower cost, than the same machine with conventional transportation in a considerably larger number of places. This is particularly true in the thinner seams. Therefore, if only four headings were required for mine development, keeping to that number would not curtail unit output or militate against low cost.

With continuous miners, the case is even more pointed. Such a machine, in effect, doesn't care whether the opening is a heading or a room. Therefore, it is not oversimplifying things to say that the production and the cost are the same. Consequently, there is no need to increase number of headings to enable the machine to do better.

Equipment for entry driving in coal normally is the same in type and general method of use as in other coal work. With mine cars or shuttle cars, any convenient layout for track or transfer stations may be employed.

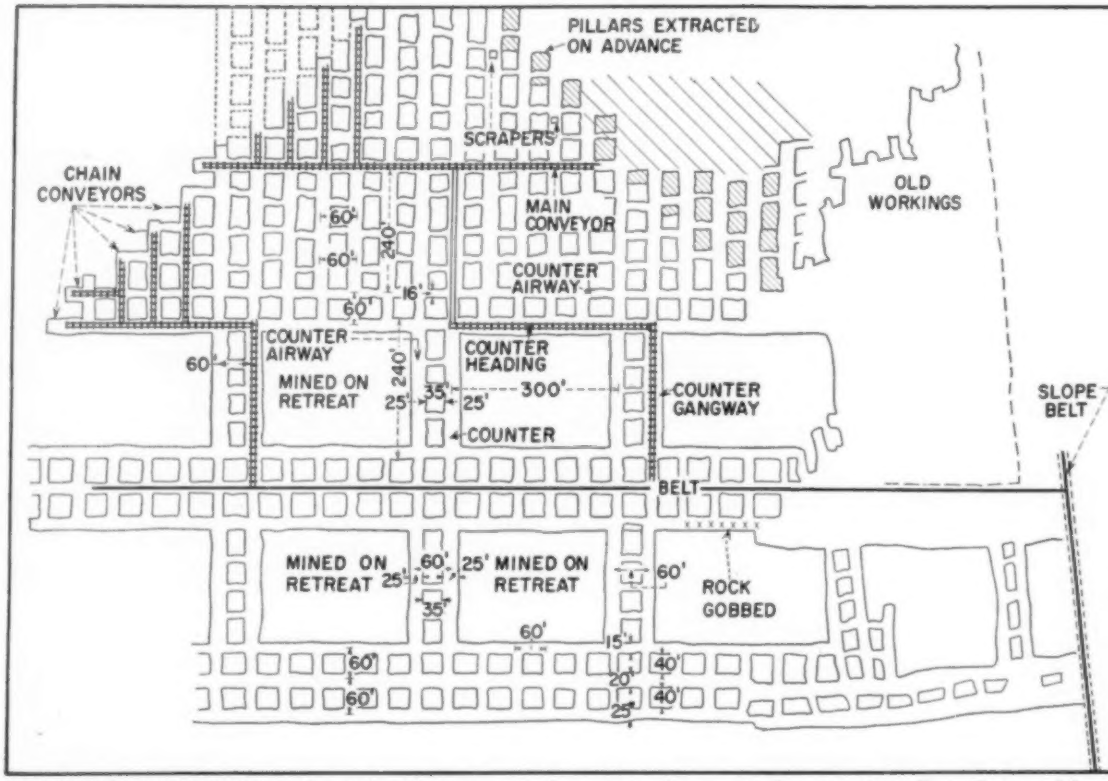
With conveyors, whether loaded by hand or machine, some form of cross unit normally is necessary to bring the coal to one point, for transfer either to a mother belt or mine cars. One layout, based on bridge conveyors (*Coal Age*, September, 1954, p. 106), is shown in the accompanying diagram. The cross conveyor brings all the coal to an elevator. Cars are loaded in trips on a loop track, with movement by a hoist. Instead of the loop track, tail tracks for pushing in and pulling out are common in receiving coal for both conveyors and shuttle cars. Frequently, to get the necessary length of tail section, it is turned into a room or through a crosscut, with the elevator on the curve. Loading sections sometimes are paralleled by passing tracks either in the same or parallel headings for greater convenience and less loss of time in changing trips. Trip control systems and equipment are analyzed in the section on "Transportation."

Crosscutting on Pitches—The making of crosscuts between gangways and airways is one of the most costly and aggravating operations in developing for pitch mining. The big drill—36 or 42 in, or larger—has been suggested and used for this purpose (*Coal Age*, May, 1951, p 100). A new unit (*Coal Age*, August, 1955, p 58) is designed for pulling the big bit by a wire rope through a pilot hole, thus decreasing drill size and also weight to a few hundred pounds. One advantage of drilled crosscuts is the fact that they are small, though still large enough to carry the required volume of air. Consequently, they can be closed with a simple wood or steel disk, rather than an expensive custom-made stopping.

Rock Handling

Where taking rock is a matter of brushing top or lifting bottom in a haulage road, as distinguished from regular tunneling, the tendency is to use coal equipment to save the cost and complications involved in employing special equipment. General practice is to alternate with coal and rock cuts, whether in the top or the bottom. Other operators, however, drive in coal various distances, usually from one crosscut to the next, or some other fixed distance—100 or 150 ft for example—before taking top or lifting bottom. This is facilitated by the use of rubber-tired haulage units.

A balancing of all the factors may result in a decision to haul all the rock made in attaining height to the outside for disposal. However, disposal in the mine avoids the haul outside and the supplementary operation of throwing it away on the surface. Some of the methods adopted for underground disposal are: (1) stowing along the rib where the opening can be made wide enough for this purpose; (2) stowing in crosscuts; (3) stowing in openings made especially for the purpose—for example, stubs driven into barrier pillars; (4) stowing in special gobbing rooms or back entries. At one anthracite operation in light-pitch coal, as an example of the latter, a lower "water gangway" receives rock from a cross conveyor laid through the crosscuts (*Coal Age*, July, 1955, p 74). In flat coal, the fact that the shuttle car is not limited to one opening or route makes it especially useful in stowing in crosscuts or special stubs, rooms or entries.



CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.

Mining and Loading

Equipment Selection

WITH THE VARIETY of equipment available today, it is only under exceptional conditions that the choice is limited and only one or two possible types can be installed. One exception—for the moment—is flat or mildly pitching seams under 30 in. Even here, there is still some choice of self-loading equipment, including the scraper and the duckbill or sawbill. Machines of the mining-and-loading type include the coal planer. Hand-loaded equipment includes the hoist-operated, scraper-type hauler and the various forms of room conveyors—chain and shaker principally. The auger, so far used for special purposes, such as preventing bumps, should be a contender in thin-seam mining in the future.

The equipment noted in the preceding paragraph also may be used in the thicker coal, and is fairly common up to 4 ft, but the development of on- and off-track loading units, which offer the advantages of flexibility and high capacity, along with ease of moving, has resulted in their taking over to a considerable extent in coal thicker than 3 to 3½ ft. Off-track haulage equipment normally accompanies off-track mining equipment, though it is being challenged by the extensible belt, the bridge conveyor and other new conveying developments providing very close to continuous haulage. Such units also can cope with very soft bottom which, in the past, has resulted in a few instances of adoption of track haulage even when rubber-tired haulage units were available.

With the exception of the planer, the auger, the stripper and the shortwall-type miner with double auger head, the trend in mining-and-loading machines, or "continuous miners," is, as with conventional loading equipment, toward mobile units. So far, there has been little use of miners of the mobile type in coal under 4 ft, though machines for mining down to 3 ft may be expected in the future. Under 3 ft, the mobile miner of tomorrow, as some see it, probably will be a remotely controlled or operated unit capable of mining across considerable distances between pairs of service openings.

Remotely controlled machines, as noted, include the auger, which has been used to a limited extent under-

10 Basic Efficiency Factors

WHATEVER THE SYSTEM OF MINING (see later sections in this Deep-Mining Guidebook for analysis of various types) the overriding goal should be keeping the face units producing at capacities as close to 100% of available working time as possible. To achieve this goal, coal should be available all the time, the machine should be in shape to work without stoppages, and means of getting the coal away should be continuously available. The job involves all echelons of operating management down to the section boss, as well as engineers and other staff men. With this as the key, the job of running a section—or a mine—takes in the following:

1. Establishing Production Standards. Assuming a machine has a rated capacity of 8 tpm and available working time is 400 min, it should produce 3,200 tons per shift. Actually it doesn't—and for good reasons. But what should it produce: 500 tons? 800? 1,000? There is a proper figure, which can be arrived at by the application of industrial-engineering principles. This means studying the operation piece by piece with a watch and a record sheet to determine not only where delays and efficiency occur, but also how much time normally should be required to perform each operation, such as "Tram to next place." When finally compiled, this information makes possible the setting of a production standard which represents a fair day's work for a fair day's pay. Normally, by making manpower more effective through better distribution of work and a better balance in the production cycle, this means a higher output than otherwise would have been attained. Savings of up to 30% in total mine cost have been reported through establishment of production standards in this fashion.

2. Synchronized Operation. Some of the benefits of balance in the cycle have been noted in the preceding paragraph. Balance also must exist in equipment capacities if over-all balance is to be secured. A cutter or a drill, for example, which is unable to keep up with the loader reduces over-all unit output while the wage bill remains the same, thus running up the cost. The synchronization phase of balanced operation becomes particularly important in conveyor places.

3. Performance Records. The need for records will vary with the responsibilities of the supervisor, manager or staff man, but whatever the degree of responsibility, daily, weekly and monthly records should be detailed enough so that the man can compare present with past performance in his own section and department, and also with other sections and departments. Delay records are almost as important as production records, since they provide the basis on which concrete steps can be taken to avoid a recurrence.

4. Trained Men. This does not mean only formal courses or schooling, though those that have installed such courses report that they are well worth their cost. But even without formal indoctrination, the alert supervisor can fairly well determine practices that contribute to low cost and safety and those that do not. Following that, he is in a position to pass this information along and work for its acceptance. Real down-to-earth training results, for example, when the cost of reconditioning a bent cutter bar is presented to an operator along with some suggestions on how to prevent a repetition. Training, too, takes place when a supervisor and a loader operator work out a scheme for attacking a fresh cut and loading it out with a minimum of moves and position changes thus shortening over-all loading time.

5. Rated Voltage. Not only does voltage less than the nameplate rating slow down equipment, particularly DC—it also breeds a don't-care attitude among crew members and burns out armatures, coils and so on, increasing maintenance cost and upping section cost. Good voltage at the working face should be a primary concern of all operating, electrical and maintenance officials.

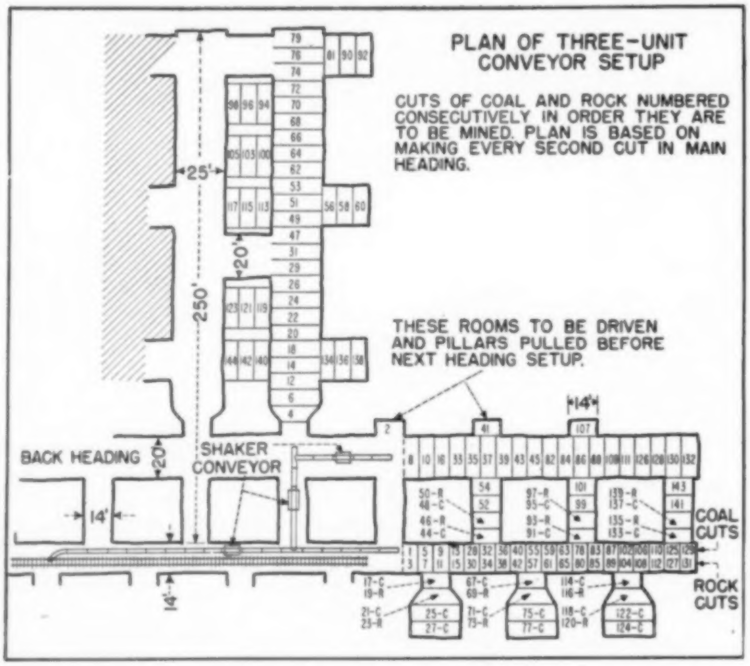
6. Expert Machine Care. Low cost today depends on keeping machines running as much of the time as possible at rated capacity. Stoppages resulting from machine breakdown cost as much as idle time from any other cause. Skilled preventive attention is the answer, meaning that a good repairman should never be too far away even if not actually stationed in the section. His main job, however, is inspection and checking to catch trouble before it starts or make repairs while they take only a few minutes rather than the lengthy periods required for major breakdowns. It helps, too, when foremen and operators have some degree of familiarity with machine design and preventive maintenance methods, including good lubrication.

7. Supplies When Needed. Small breakdowns can have severe consequences when it is necessary to send outside or to some other distant point for a part that should have been in the section stores. The moral is to make sure that the supply items of the right type are at the right place at the time they are needed. This includes even mine props, roof bolts, rail, ties and anything else the lack of which might slow down or stop production.

8. Transportation When Needed. "Continuous" transportation is provided by conveyors, but depending upon the type of production and haulage facilities, shuttle cars and rail cars can provide the equivalent of continuity under most circumstances. The need for "continuity" also applies to mainline haulage, which should be set up to have an empty trip at each transfer or loading station before the previous trip is loaded out. Also, transfer of coal to cars should take place without delaying the shuttle car or conveyor, meaning that facilities should be provided for shifting cars while the coal flow continues, unless, for example, shuttle-car and mine-car capacities are identical.

9. Competitive Spirit. Pride in achievement is a powerful stimulus to excellence in results, whether in production or in baseball. A "beer bust" is one form of reward for a record-breaking job, but incentives do not have to be tangible to achieve results. Merely pointing out the crew standing, with praise if at the top or with pointed reminder if down the list, usually can stimulate the competitive spirit to a substantial degree, with consequent salutary effect on production and cost.

10. Safety Always. Last but by no means least in any set of principles for running a mine or a section is constant emphasis on safety. Aside from everything else, injuries cost in increased compensation and medical payments, in lost output, and very frequently in damage to mine and equipment. Even where no injury results, a roof fall, for example, can tie up machines and involve anywhere from a minor to a major removal and cleanup expense.



HEADING ADVANCE alternates with room work in this conveyor plan based on mining on one side on the advance and on the other in final retreat. Rock is loaded every second cut in haulage heading, where necks are made extra deep.

ground. This use is expected to increase. Other than the auger, remote machines so far placed in service have been controlled and operated from the surface. Operating them from underground stations involves an engineering and design problem of some magnitude, though not an insurmountable one. One big advantage of remote mining is the fact that exposure to roof hazards is sharply reduced. A second is that production places need not be timbered or bolted. On the other hand, control equipment, special cable reels and cable, and the like are additional or more-expensive items. However, results from initial remote-mining operations are such that their continued growth in the future is assured.

Pitch Equipment

Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 18 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in crosspitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be employed is yet to be determined. However, a Canadian-developed ripper-type miner for longwall work has successfully operated for considerable periods of time down a pitch of 30%.

Explosives and gravity remain the major production tools where greater than sheet iron pitches are encountered. To make it possible to bring these forces into play with a minimum of labor, major emphasis is being placed on the development of the longhole drill.

Conveyor Mining

ALTHOUGH THE VARIATIONS are almost infinite, conveyors today normally are used in groups of two to four. Benefits are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyers usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Chain conveyors—belt units seldom are used in room work or heading advancement—require a drive for any change in direction. It is possible to bend standard chain units slightly, though it is not recommended because of increased wear. Thus, when hand loading onto chain units, it is necessary to keep place width down to practical shoveling distance unless face conveyors are used. With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other conditions are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency. And even though the face conveyor is longer, putting it on wheels or rollers and designing the joints for quick breaking and making (*Coal Age* October, 1952, p 77, for an example) permits rapid moving even where close timbering is necessary.

With shaker conveyors, swivels make it possible to swing the face end rather readily, provided jacks and posts do not interfere. Thus, within limits it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Ability to use swivels and turns permits driving crosscuts and working pillar places without separate drives. Bellcranks also permit operating separate trough lines from the main unit as desired. Uphill types with curved discharge chutes also can lift coal or rock and load it into cars without auxiliaries.

Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills. Compared to loading by hand, adding a duckbill, sawbill or power duckbill increases the number of cuts that can be mined in a shift by from one to three, thus, in some instances, as much as doubling the output per shift.

Conveyor Plans

The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides, as in the plan shown on p 35. Though this plan involves auger-head mining the conveyor layout is typical of those used with hand or machine loading.

Where the coal pitches and entries or gangways are driven on the strike, places are turned up the pitch.

Occasionally, as demonstrated in the accompanying illustration, a sub-

opening may be established up the pitch to permit two or more groups to be operated in cascade fashion. A variation is driving stubs up the pitch, equipping them with proper lowering equipment, then turning rooms across the pitch starting at the top of the stub and working down.

2. Developing the room entry and at the same time working rooms on one side on the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more even output rate over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system. In driving and advancing on one side, the entry, as shown in the accompanying plan, may be advanced a certain distance and then the equipment moved into the rooms to mine them out, after which another entry advance is made.

In any system, most operators like to prepare room necks in advance. Thus, if the entry is completely developed in advance, places may be necked 2 to 3 cuts on one or both sides to be ready for final mining—that is, with a two-heading entry. However, if chain-pillar crosscuts are made on room centers necking may be unnecessary on one side. And with a three-heading entry, with the belt in the center, crosscutting on room centers can eliminate any necking on either side, though many operators still feel that it is worth driving in to the point where room widening starts. Also crosscutting on such short centers may be undesirable from several standpoints, including extra stoppings and more likelihood of roof trouble.

Pillar Extraction—Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the timber that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual practice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed. In mining individual pillars, any one of the conventional methods—slabbing, pocket-and-stump, open-end, and so on—may be used, depending upon conditions and managerial preference.

Unit Organization

Aside from the room and—possibly—face and cross conveyors and elevators, the usual practice in setting up a conveyor unit is to put a shortwall cutter and a drill in each place. Attempts to move cutters from place to place make it difficult to set up a tight face cycle, which is essential for maximum efficiency. Drills may be separate, each with its own cable, though a common practice is to plug drills into cutting-machine takeoffs. Flexible-shaft drills, likewise operating from cutter takeoffs, have made major strides in conveyor and other mining in recent years, as has the hydraulic hand-held drill powered either from the hydraulic system on the cutter or, if the cutter has no hydraulic facilities, from a special portable pumping unit.

Other equipment frequently found in a conveyor setup includes specially designed rockdusters and bolting units. Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face in pitching coal. The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reached, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and the line is pulled up by the cutter so that the inby pan can be unloaded and added to the regular line. When the last section of the false line is pulled up, the room is completed.

Outby the rooms, supplies may be brought in by rail trucks, by rubber-tired equipment or by reversing the panel belt. Some belts have been fitted with jogging and inching controls for this purpose (*Coal Age*, April 1946, p 86). In moving drives from one group of rooms to another, power usually is provided by the cutting-machine rope. Shortwall trucks make handy carriers, however, and are widely used. Crawler-mounted cranes (p 128) and special carriers, some equipped with winches, also may be acquired for moving drives, pans and other heavy units. Light three-wheeled trucks and even toy wagons are good devices for moving smaller items.

Scheduling Face Work

The usual face crew, whether loading by hand or power, is 3 or 4 men, with as high as 10 to 12 on extra-long faces. Average output, hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift—sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. Unless places are extra-wide or some special situation exists, the usual face crew, as noted, is 3 to 4 men. More than that number under normal conditions seems to result in interference and lost time.

The cycle itself is the critical factor in high productivity. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible. The best way of attaining it is through time study and the establishment of a fairly rigid system of standard times, plus a fairly exact schedule of when to do what each cut. If successful, all the men know what to do and when to do it, and their activities in the cycle mesh at every stage in preparing for and mining a cut of coal.

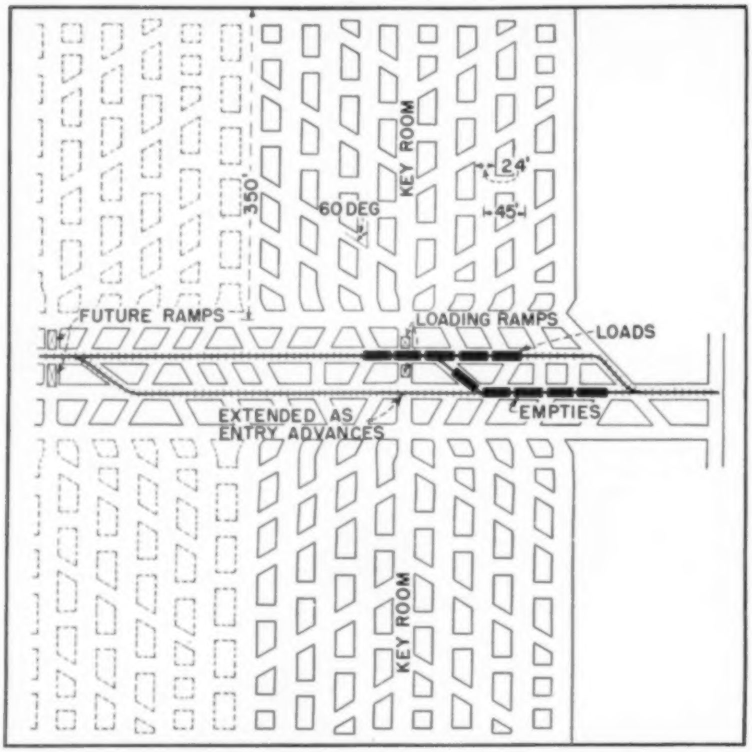
Machine Mining

THE BASIC machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining including semilongwall, in both thick and thin coal and in both flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

Machine Projections

Because of the flexibility of the loading unit previously noted, mining plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the



SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts for faster shuttle-car travel.

coal into blocks of uniform size, permitting both flexibility in attack and, at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar line from 45 deg—sometimes down to zero, or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span is reduced, the weight of top in the angle requiring support is reduced accordingly. In one instance a change from 45 to 22½ deg, with a minor change in block centers, cuts the weight to be supported to one-third of the total under the 45-deg plan previously employed.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines as a result of permitting entry recovery to lag behind to provide room for a tail track, as well as permitting one group of rooms operated by one mining unit to get considerably ahead of the next group. The conclusion therefore is that with most top there is considerable flexibility in establishing and operating pillar lines, though, other things being equal, a reasonably long straight line normally provides the maximum results with a minimum of trouble. And whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left. Much of the trouble on pillar lines results from forgetting this rule.

Preventing Bumps—In brief and perhaps oversimplified terms, bumps are the result of a concentration of stress in the interior of a block or blocks of coal as a result of weight. As the weight builds up, the coal in the pillar is stressed more and more, until it suddenly fails in explosive or semi-explosive fashion.

Preventing weight buildup is a combination of a number of things as outlined in a more detailed discussion of bump prevention in the section on "Roof Control," p 46. Careful study will permit evolving a mining plan which will eliminate or reduce load buildup of the type which results in bumps.

In addition to mine layout, pillar design and pillaring system, bumps may be avoided by drilling or augering suspected pillars. In this process, the weight is unloaded gradually, or the bump is triggered while the weight concentration is small and before actual mining of the pillar starts. For a fuller description of the pioneer drilling and augering plan for bump control, see *Coal Age*, January, 1955, p. 68.

Machine Plans

A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

Shuttle-Car Haulage—Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted elsewhere in this section, are set up with all openings on the same centers so that pillar

lines can be established and advanced without having to shift gears when an entry is crossed.

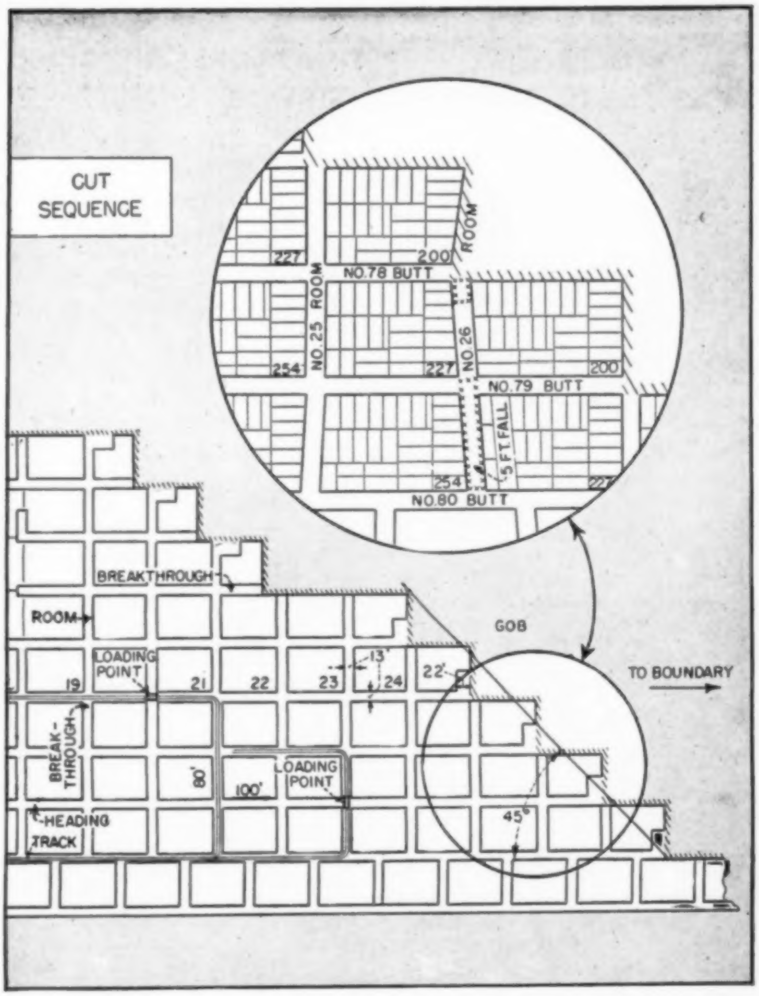
In developing for both plans, the usual practice is to drive a minimum of 4 or 5 headings to make entry work as near like room work as feasible and thus as efficient as possible. Heading stations are established every 200 to 300 ft, at which distances the shuttle-car haul is kept under the generally accepted maximum of 500 to 550 ft. If track is used, it may be looped completely, or may be turned into a room or back down the next heading to establish a tail track for transfer from shuttle car to rail car.

Crosscuts may be angled each way from the center heading to facilitate higher-speed shuttle-car operation. This is especially true in operations based on mining individual panels, and particularly where pillars are left. In some plans, the angle crosscuts continue to become rooms, with angling continued in making room crosscuts. In a group of five or more rooms, for example, the center usually becomes the key room, often leading directly to the car or belt-loading station. An example is shown in the accompanying plan, with four rooms on each side of the key room and track in two headings for fast handling of trips with a minimum of stoppages in loading.

Three other plans accompanying this section show right-angle revelopment for pillaring, and loop tracks for loading. Two also show bleeder headings and one is an example of how new openings are driven to develop blocks for pillaring only as needed.

With track setups, all shuttle cars normally must dump at the same point. Consequently one must occasionally wait on the other. Where panel belts are used instead of track, however, some operators restrict one shuttle car to dumping at the end and require the other to use a crosscut farther down to prevent interference and loss of time in waiting to use the same dumping point. Where possible, also, this same separation of routes is carried to the face, except for the opening in which the loader is working.

Extra-thick coal offers some special problems in machine mining. At one mine, as an example, though the mining system went through a number of changes, all openings invariably were driven along the bottom. Top and rib deterioration and the onset of weight always outpaced the rate of extraction, thereby making it difficult to achieve the desired recovery. The cure was found in driving the openings in the top of the seam and bolting the roof, which permitted fast, economical removal of the lower portion of the pillars by loader or scraper (*Coal Age*, November, 1954, p 92).



LOOP CIRCUITS simplify rail haulage and keep cars right end to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.

Track Haulage—In loading directly into mine cars, maximum efficiency involves these steps:

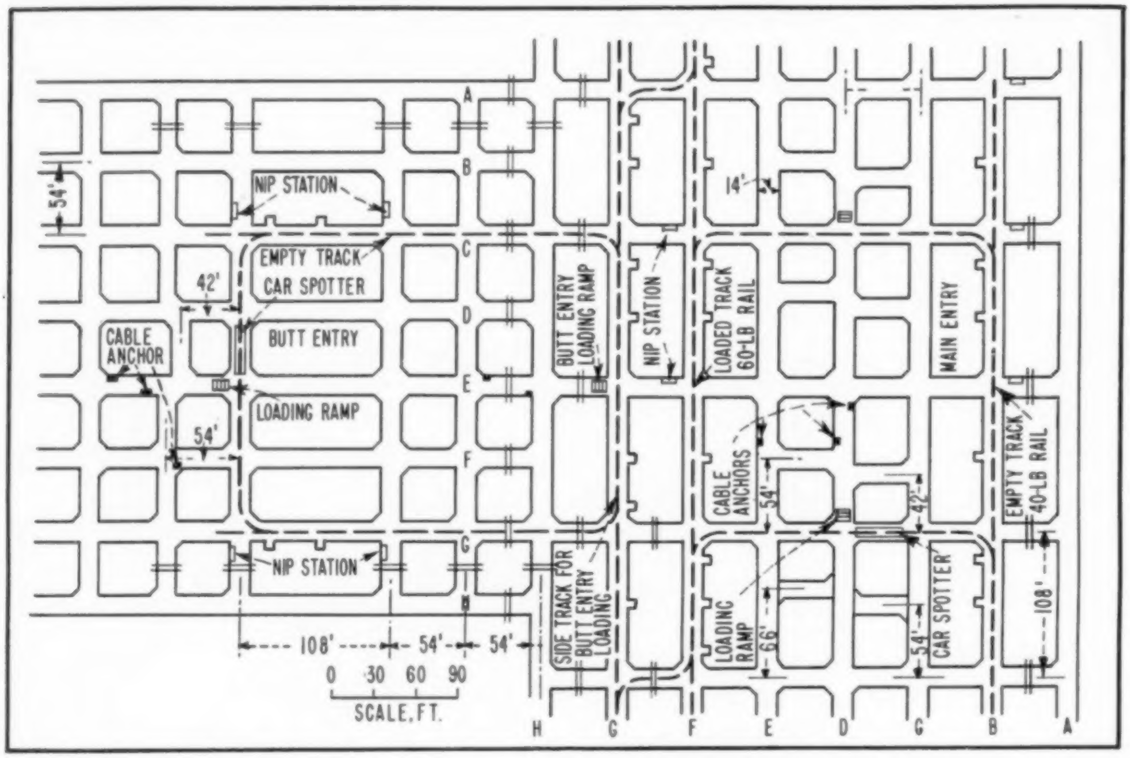
1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Prefabricated track provides a reliable means of attaining the second objective, as well as the further goal of track that can be installed, taken up and moved quickly and with a minimum of labor. Prefabricated track also forces adherence to the mining plan, which is helpful over both the short and long pulls.

Conveyor Haulage—Being a continuously operating haulage unit, the conveyor was early seized upon for service behind loading machines. The difficulty of keeping the machine discharge over the conveyor, with consequent loss of time by the operator, added to the time and cost of moving the conveyors, resulted in, first, a trend to mine cars and, next, to shuttle cars. New types of units, however, are putting the conveyor back into the loading-machine picture. An example is the bridge conveyor, which is connected directly to the loader to provide a continuous conveying line.

Bridge-conveyor plans normally are based on two or three places per unit. Basic equipment in the unit is two or



ROOM WORK is eliminated in this mining plan in favor of straightaway advance in eight butt headings, followed by mining of entry pillars.

three room conveyors, two or three bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moves from place to place, and a mounted cutter may be substituted for the individual shortwalls, alternating with the loader. In general a good top or one which lends itself to bolting facilitates the use of bridge conveyors by making it easy to establish the necessary travelways.

Operation is much the same whether rooms or entries are being driven. An entry-driving setup is shown on p 22 of this issue. Average performance in 34-in coal is 20 to 25 tons per faceman. One element in this performance is a tight well-balanced cycle, involving four men approximately 30 min in preparation and two men 30 min in loading, as follows: (1) two men drill two shot holes; (2) two men sump cutter; (3) one man continues to cut while helper and third man drill three remaining shot holes; (4) one of the latter two loads, tamps and prepares to shoot while the other sets permanent timbers to replace safety jacks; (5) fourth man installs conveyor pan and cleans up loose coal; (6) face is shot; (7) loader crew of two men loads out the cut. Note that preparation and loading require identical times, meaning no lost time for the loading machine. Steps to achieve this goal include bug-dusters on cutting machines, 8½- and 9-ft cutter bars, and crawler trucks and three-wheeled push carts for handling equipment and supplies, plus loop track to reduce car-change time.

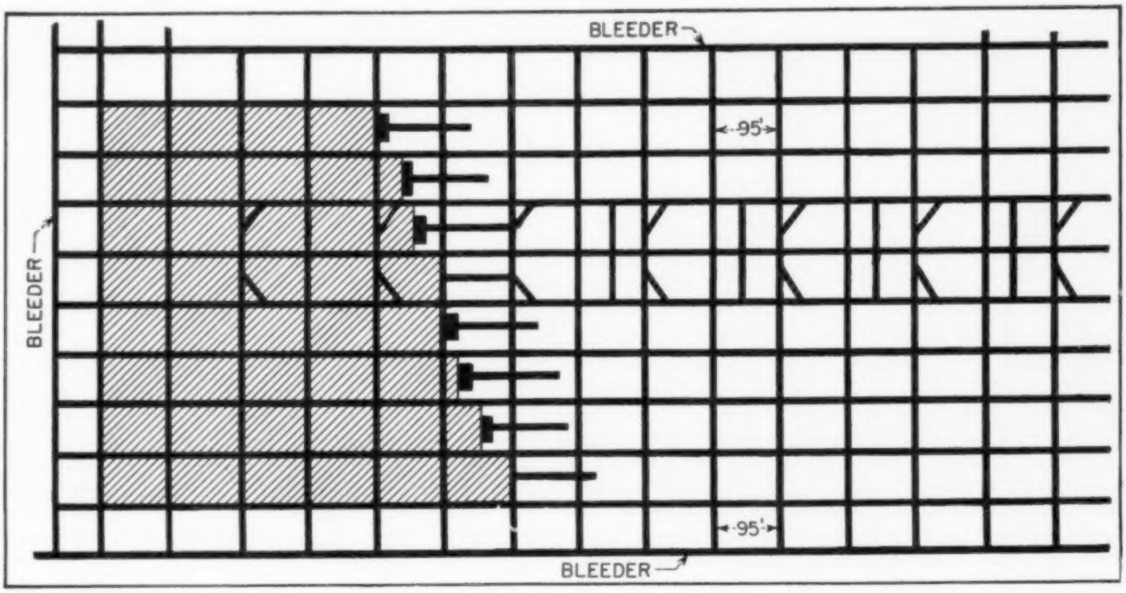
Pillaring Plans

Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. A variation of the latter is pocket-and-fender, under which the stump is cut down to a shell only 2 to 3 ft thick. A sub-variation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section of this Deep Mining Guidebook. In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib bursts, particularly when heavy weight is the rule and the coal is soft.

Continuous Mining

THOUGH MUCH EXPERIMENT and development remain, continuous mining is beginning to enter the stage of reliable production at maximum rate.

As with earlier mining equipment, the emphasis in the United States has been on mobile machines, even though the actual mining principle ranges from ripping to boring. As a result, most of the continuous production comes from room-and-pillar or block systems, modified as necessary to take fuller advantage of the potentialities of the miner. And as with older-type equipment, the machines



BLEEDER HEADINGS with flat-angle pillar line and loop track feature this block plan designed for shuttle-car haulage. Blocks are split on retreat and the halves are recovered by open-ending.

are used either for room work alone, leaving pillars, or for full extraction, including taking the pillars. The No. 1 problem, as with conventional mining, is haulage behind the miner that will permit it to work the maximum time. The second is roof support and the third is keeping the miner in operation. These problems are treated in more detail in other sections of this Deep Mining Guidebook and in the Maintenance Guidebook in this issue.

Continuous Projection

The mobile design of practically all mining-and-loading, or "continuous," machines used in the United States and Canada has resulted in projections very similar, for the most part, to those previously employed for conventional loading and, earlier, for hand loading. Certain exceptions, used with special equipment, such as the planer, are discussed in the "Longwall" section of this Deep Mining Guidebook.

Even though the plans are generally the same, mining with continuous units differs basically from mining with earlier equipment in that the continuous machine can stay in one place, compared to loaders, for example, and can produce "continuously" from that place, compared to the intermittent production from, say, conveyor places, where the need for cutting, drilling and shooting, even though overlapped with each other and with loading as far as possible, necessarily cannot be arranged so that loading is continuous.

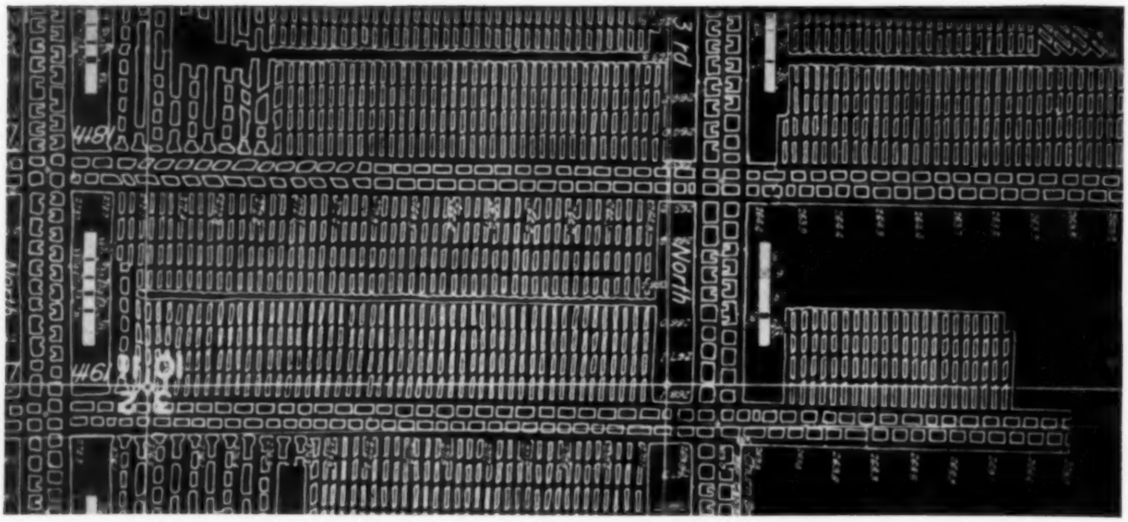
This ability of the continuous miner to get all its tonnage from a single place has, among other things, eased the problems of entry-driving and development in at least some respects. With continuous equipment, only the number of headings required for haulage, travel and ventilation—no more—need be driven. In contrast, with machine loading the number frequently was increased to permit the unit to operate more nearly at potential capacity and efficiency, even though this involved, as an example, more temporary and permanent support, stoppings and so on, aside from the inherent handicaps of operating in places of less than normal room width. Now, with continuous equipment, a number of operators are cutting down on total number of headings in main, cross and room entries. However, if desired, the number may be maintained or increased to fit in with certain types of mining, such as, the block system with all openings and pillar sizes uniform.

Continuous equipment also provides an opportunity for a concentration of production previously impossible to attain. As an extreme example, all the machines necessary for the desired output per shift may be stationed in adjoining places, and the places may be either rooms or entry headings with no significant difference in output, other things being equal. One bar to heavy concentrations, however, might be the corresponding increase in the rate of gas liberation, which might make it difficult to get enough air to the points of coal production to keep the percentage below safe limits at all times. High concentration also may add to the difficulties of providing continuous haulage, handling men and supplies, rock-dusting and so on.

With conventional forms of transportation, such as, shuttle cars or standard room conveyors, "room" depth necessarily is much the same as with conventional equipment. New transportation units, on the other hand, such as, the articulated and extensible belts, permit changing projections to provide for "room" lengths up to 1,000 ft. Thus, along with the fact that the continuous unit simplifies the entry-driving phase of development, even fewer entries are necessary with the long rooms.

Room Systems

An example of 90-deg continuous mining with ripper-type machines, leaving thin pillars, is shown in an accompanying illustration. Using shuttle cars and belts, the rooms are mined on the advance on one side, and on the retreat on the other. One feature of this plan is the establishment of the crosscutting pattern with the driving of the first two rooms, as shown. Thereafter, the crosscuts are turned and driven pillar thickness deep on the solid side, while those on the opposite side are picked up



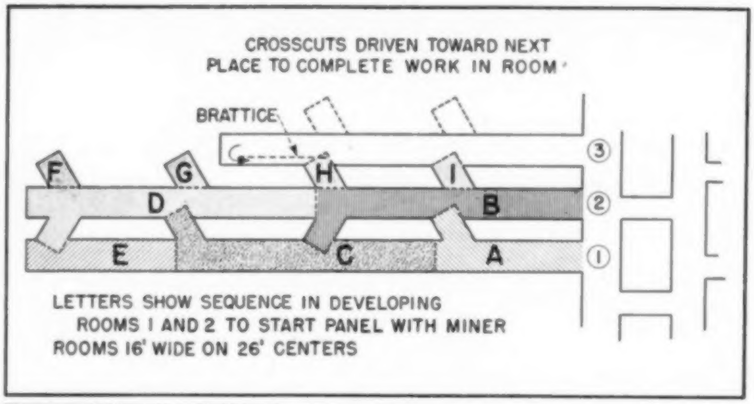
CONTINUOUS-MINING PLAN designed for advance on one side of panel and retreat on other, with short room centers and pillars left in place. Plan below shows sequence of driving and crosscutting in first two rooms to establish ventilation.

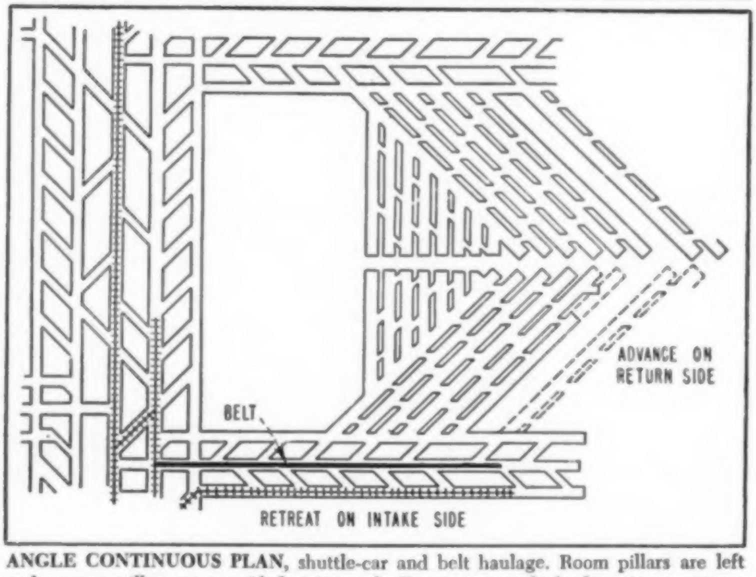
automatically as the place advances.

To facilitate shuttle-car haulage to panel belts another user of ripper-type equipment turned places on a 45-deg angle, and omitted every 6th or 7th room to form a squeeze pillar and barrier. Rooms are turned both ways from the three-heading panel entry, which leaves a triangle between the outby ends of adjacent sets of entries. This triangle is mined by turning sub-rooms, again at 45 deg, off the No. 1 room on each side. The panels are "closed" in that they are surrounded by solid pillars except where the panel entries come in. Rooms are worked on the return side of the air current on the advance.

A modification of this system to permit using the extensible belt consists mainly of making the rooms 600 ft long. The three headings making up the room entry are driven with shuttle cars, with crosscuts at 60 deg from the belt heading. Each of the six rooms in a group is driven separately, advancing on the return side of the panel and retreating on the intake side, as shown in the accompanying plan. In addition to heading advancement, shuttle cars are used in making chutes across the chain pillars, and for recovering timber (see Room 12).

A recently developed plan for the auger-head miner, as shown in the accompanying illustration, is based on earlier conveyor setups. As shown, the entry is first driven up and the rooms are mined retreating, with two miners and accompanying bridge and room conveyors on each side. In entry development, coal from the three side places in the four-heading setup is





ANGLE CONTINUOUS PLAN, shuttle-car and belt haulage. Room pillars are left and squeeze pillars are provided at intervals. Rooms are worked advancing on return side of panel and retreating on intake side.

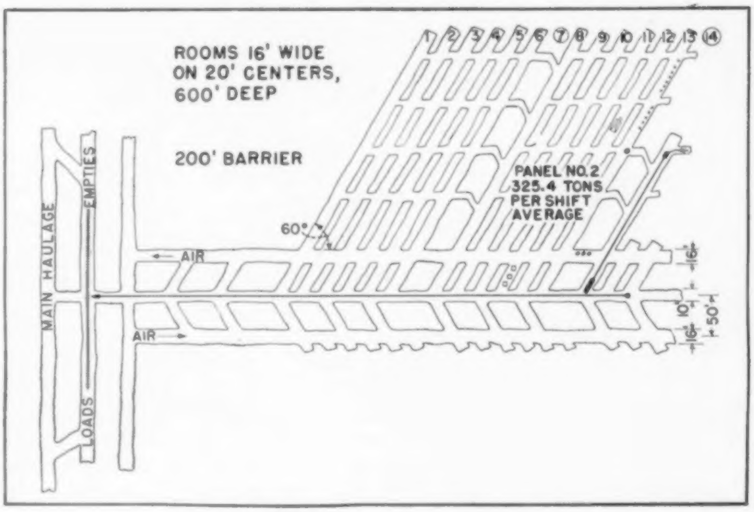
brought to the mother belt by cross conveyors. (*Coal Age*, March 1956)

Pillar Systems

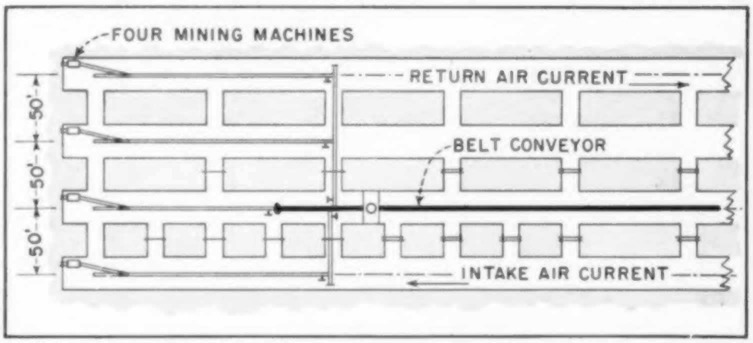
Projections for continuous pillar-mining systems, as for room systems, are as previously noted, fairly similar to those for machine and hand loading. The major difference to date seems to be in a tendency toward blocks rather than long rectangles, and toward flat or low-angle pillar lines rather than the conventional 45 deg.

Stepped lines (see accompanying plan for example) also are more frequent, though the intervals seldom are more than the equivalent of one or two pillars or blocks. Width of a step seldom is more than 3 or 4 places, and in some instances is only one. Steps in lines pose the same problems of weight on projecting points as weight on stumps in a standard 45-deg line (see "Machine Projections" in the section on "Machine Mining"). However, as noted, many operators are finding them helpful as well as satisfactory where top is good and weight on points is not excessive.

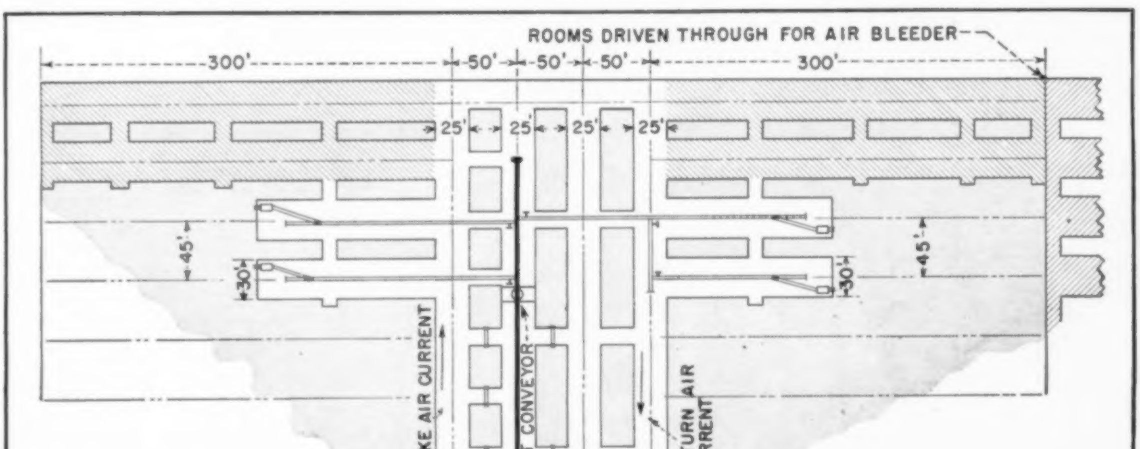
Following through on the similarity between continuous and conventional plans, full retreat or advance one side and retreat the other in a panel is a common system with continuous equipment. An example of the latter is shown in an accompanying plan, also featuring bleeder openings. In this plan, three rooms are driven through to the previous bleeder. The pillars between Rooms 1 and 2 then



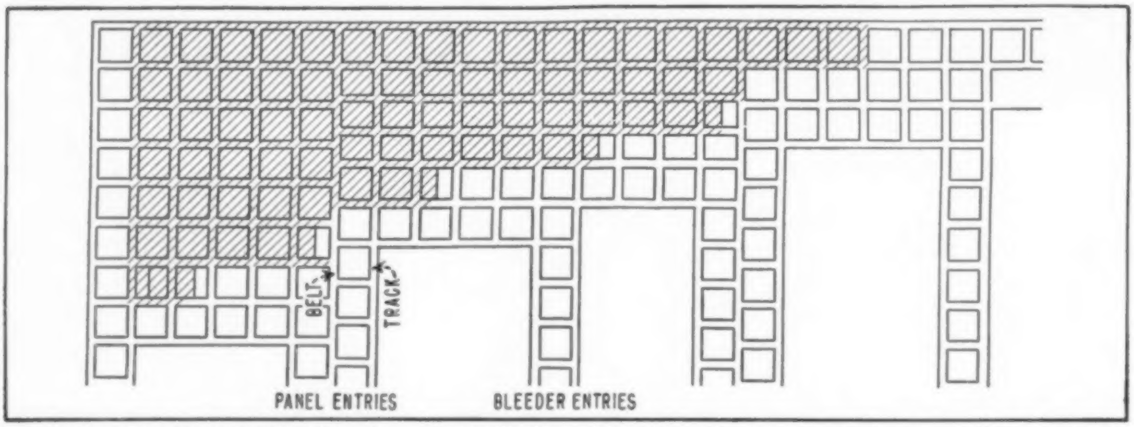
ANGLE CONTINUOUS PLAN with extensible belt for room haulage. Places are 600 ft deep and are worked advancing on one side of panel and retreating on other.



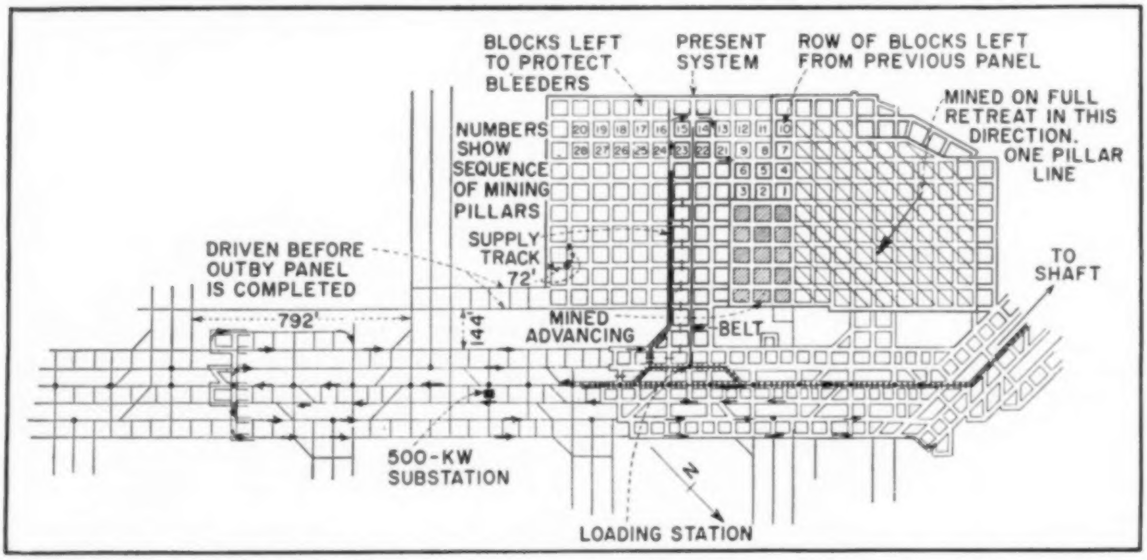
ENTRY DEVELOPMENT with auger-head miner in 36-in coal.



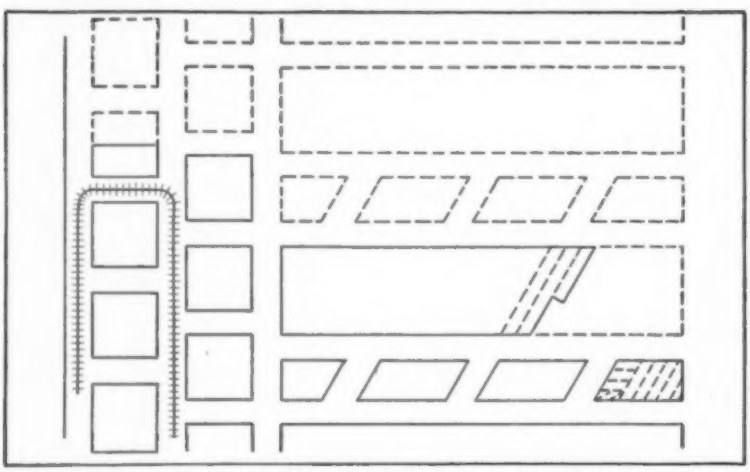
PLAN FOR AUGER-HEAD MINER feeding to bridge and room conveyors. Entries are first advanced to limit and then the rooms are brought back two abreast on each ride.



BLOCK-TYPE CONTINUOUS PLAN, with stepped pillar line and bleeder entries between panel entries. Pillars are removed by splitting and then pocketing through the halves, leaving small fenders.



ADVANCE ON ONE SIDE OF PANEL and retreat on the other features this continuous-miner plan, which has a minimum of open territory. Rooms are driven on the advance on the return-air side and the pillars recovered. Recovery is 85 to 90%.

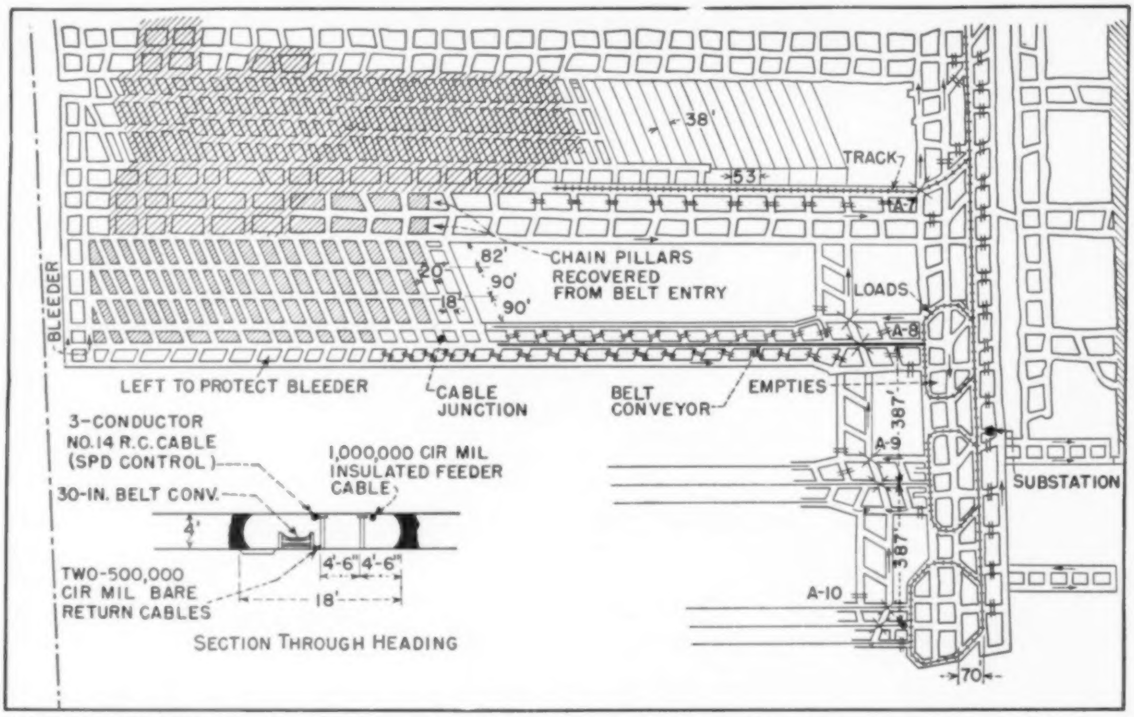


ANGLE PILLARING PLAN for rigid-head miner is based on solid pillars between pairs of rooms. Recovery is done by open-ending.

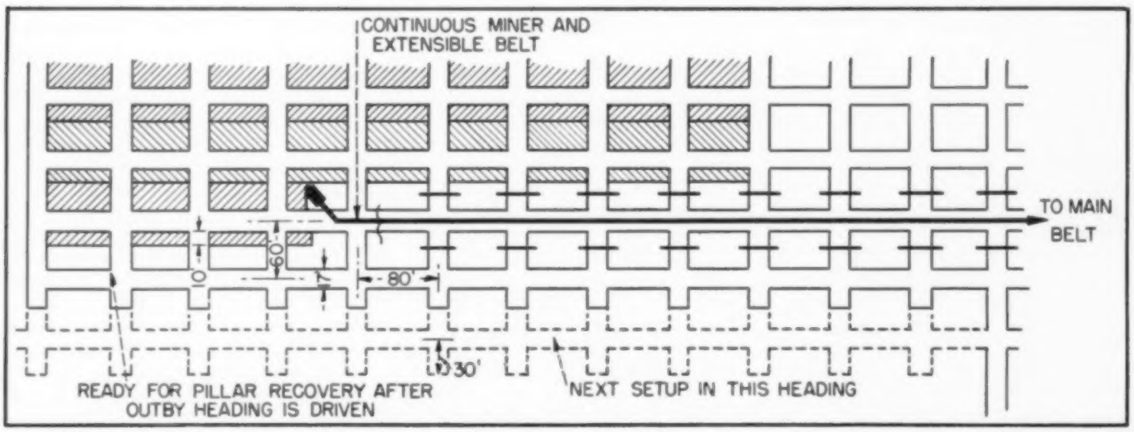
are removed. Two rooms always are kept open ahead of the advancing pillar line by driving a new place as each line of pillars is completed. Thus mining alternates between rooms and pillars. When the top of the panel is reached, the pillars are brought back retreating leaving blocks as indicated to preserve the bleeder openings.

Even with the so-called "rigid" machines, the tendency is to put continuous mining work on 90 deg. An example showing initial and subsequent panel development in a mining area, as well as haulage setups using both panel belts and track is given in an accompanying illustration. Like many other systems it features bleeders, including a special bleeder heading at the tops of the panels.

Angle plans for rigid-head machines



ANGLE DEVELOPMENT with rooms on one side of the panel entry only features this retreat-mining plan for rigid-head machines in medium coal. The plan includes bleeders and loop tracks for handling main-line trips.

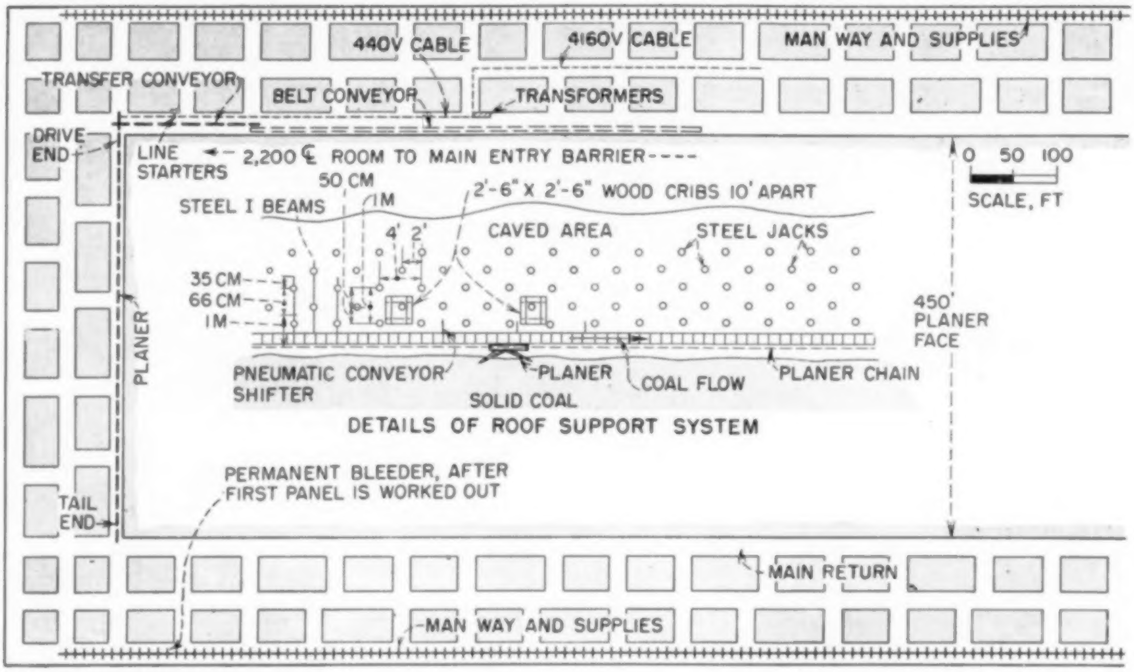


EXTENSIBLE BELT permits driving places 1,000 ft deep with continuous miner. The pillaring plan shown is one of several designed to take advantage of extensible-belt characteristics.

include the one shown in an accompanying illustration (*Coal Age*, June, 1956, p 78). Haulage is by shuttle car to panel belt to cars on loop track at the mouth of the panel. As indicated, the popular bleeder openings are provided. The coal is thin and the rooms are driven on short centers to narrow the pillars. The miner alternates from one to another of two rooms each time it reaches a crosscut. When a room is completed the pillars are mined by open-ending.

With square or nearly square pillars, the general practice is to split and then open-end the two wings, with or without leaving a small triangular stump or peg next to the gob where the lift is started. However, some angle plans are worked. An example is shown in an accompanying illustration. It involves driving pairs of rooms on short centers, leaving a fairly thick solid pillar next to the gob. The miner is a boring-type unit, and both the solid gob pillars and the room pillars are mined by open-ending at angles of 45 to 60 deg.

With the conventional rectangular pillars, the usual practice is to take lifts off the gob end, either with or without leaving stumps, pegs or fenders, protecting the equipment and unmined coal with conventional breaker sets. Lift length is a consideration in fixing pillar size for best results. Short lifts require more frequent moves, especially in thin coal, whereas extra-long lifts, especially if open-ending is the practice, increase the hazard of losing the face, damaging or destroying equipment and injur-



COAL-PLANER SETUP in 40-in coal, 450-face, collapsible steel jacks, headers and cribs for roof control.

ing men. If practice to date is an indication, the best length of lift seems to be around 30 ft in thicker coal, running up to 80 ft or so in thin coal with reasonably good top.

Lift width in open-ending with rigid or semi-rigid machines normally is head width, compared to width-and-a-half or double width in room and crosscut work. Pocket-and-stump or pocket-and-feeder recovery, however, eliminates the open side. Therefore, as in room work, the tendency with these types of pillaring is to drive width-and-a-half or double because top conditions or gas emission may make it undesirable to advance single width past the operator's station without advancing roof support and brattice.

What might be called "special" systems for pillar extraction with continuous miners includes one worked out for ripper-type machines with extensible belts (*Coal Age*, July, 1955, p 50). As indicated in the accompanying illustration, places are 1,000 ft deep, and the development plan is based on keeping an open place ahead. Thus, in the active pillar place, all the pillar on the gob side is removed and a 10-ft cut is taken off the opposite side, working back to the mouth of the place. Then, the miner and belt leapfrog the next place (previously driven to its limit), and drive a new place. When it is driven to its 1,000-ft limit, the head and tail sections of the extensible belt are trammed back to the place previously leapfrogged. The intermediate sections and belt are left in the newest place for use in pillar recovery. This cuts time to put the belt into operation to a minimum when the head and tail—and the miner—are trammed in for pillar recovery.

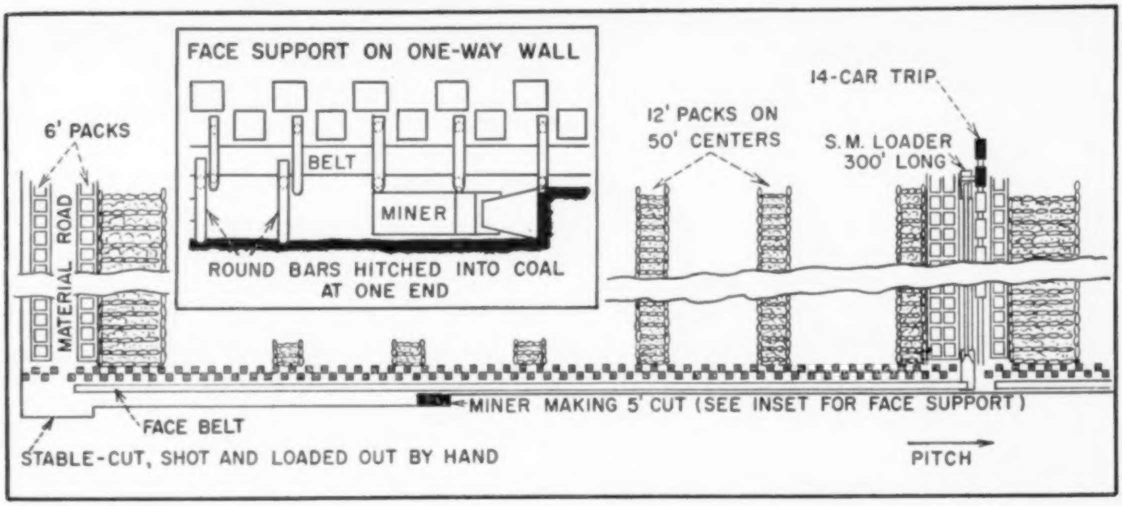
Longwall

ROOF CONTROL is the heart of longwall mining and requires not only special support systems but also considerable specialized experience, compared to the conventional room-and-pillar system. Also, the usual type of equipment designed for room-and-pillar and properly operated gives such a good account of itself that longwall finds it difficult to compete in the thicker, flat seams.

For these and other reasons, longwall in the United States and Canada is so far limited to thin or pitching coal, as a rule. Also it is largely limited to special types of equipment, such as, the stripper or planer, or special ripper equipment operating open-ended. However hand-loaded conveyors and self-loading scrapers still are used on faces established between pairs of entries or by slabbing rooms. Slabbing to remove a thick solid pillar by widening the original room also may be done with loaders served by shuttle cars discharging to mine cars or a panel belt (see *Coal Age*, June, 1953, p 84, for example). In most slabbing systems, solid pillars are left at intervals, and thus the advance of the face is intermittent.

An example of a longwall face designed for planer mining is shown in an accompanying illustration (*Coal Age*, May 1956, p 72). Face length is 450 ft and average production per shift in 40-in coal is 500 tons, with the maximum 1,000 tons. The aim in roof control is to cave the top behind while keeping the face open with collapsible steel jacks, headers and cribs.

A second illustration shows a face designed for a ripper-type longwall unit under heavy cover requiring packwalls. The walls are established up and down the pitch and the miners operate on pitches up to 18 deg. Length of a wall is approximately 500 ft, or no more than a machine can clean up in a shift. This is necessary because conditions are such that all supplementary work—advancement of conveyor, packwalls and face support —must be done on the offshift, and failure to complete the cut would mean losing a day in the production cycle. On light pitches the machines



PITCHING LONGWALL FACE under heavy cover, with special ripper-type miner discharging to face belt. Main support is packs and cribs. Face support is round bars hitched into the coal.

cut both ways. On heavier pitches, it cuts downhill only and is trammed back to the top of the wall on the off-shift.

Originally, the miner discharged to a belt conveyor alongside. "Python"-type flexible chain conveyors are being substituted for the belts, and are pulled over by the miner itself as it returns to the top of the wall in the heavier pitches, thus releasing a conveyor-moving crew of 8 men for other productive work. An incidental benefit is an increase in wall production by eliminating the spillage encountered with belts. On some of the longer walls, this runs to 30 to 40 tons per shift.

Theoretically, longwall provides the maximum in continuity of production, but roof control normally requires more support and more labor to install it, in addition to other special requirements and facilities. Thus, as noted, it finds it difficult to compete with conventional equipment in thick, flat coal. However, particularly where thinness or pitch prevent the use of conventional equipment, the continuity of production with longwall methods and modern longwall units normally—though not always—more than offsets the cost of extra support and facilities, with resultant significant increase in tons per man. Thus, one planer in 3-ft coal has raised output per man-shift to the parting 2 to 4 tons compared to production with conventional methods, while the ripper-type pitch unit has gone over 600 tons in a mining shift with tons per man to the car-loading station, loading shift only, of over 50. Average mining height is approximately 4½ ft.

Pitch Mining

PITCH MINING may be defined as mining on grades greater than those that can be negotiated readily by mine cars or shuttle cars, or around 5 to 6 deg. The maximum on which crawler-mounted equipment can be moved without too much difficulty is around 15 deg. Light-pitch mining may therefore be defined as mining between 5 and 15 deg. Heavy-pitch may be defined as the degree of pitch at which the coal will run on the bottom. This normally is something over 35 to 40 deg. By elimination, therefore, the moderate-pitch area becomes that between approximately 15 and 40 or 45 deg.

Light Pitch

Practically any type of equipment may be used at the face of places driven either up or down light pitches. Normally, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring, and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit easier movement of units from place to place in conventional machine loading.

Moderate Pitch

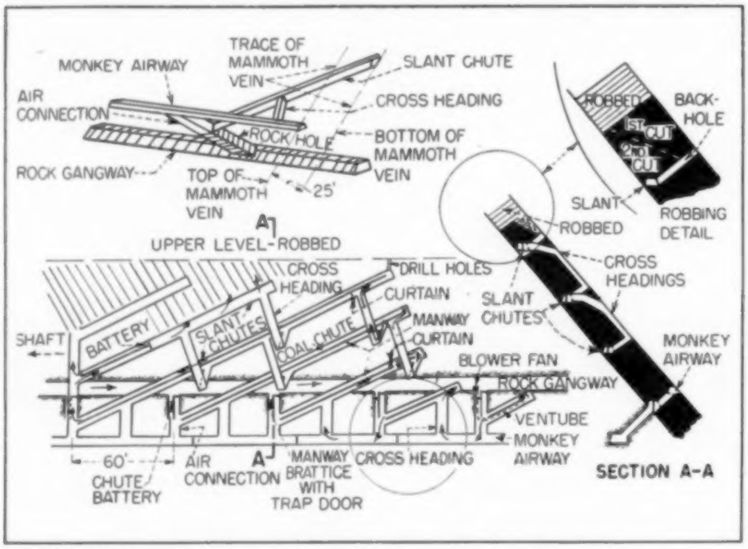
Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron and, at something around 35 deg, on wood. Below approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of rooms up a 45-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one, with a second pan line along the upper rib which serves to bring in supplies.

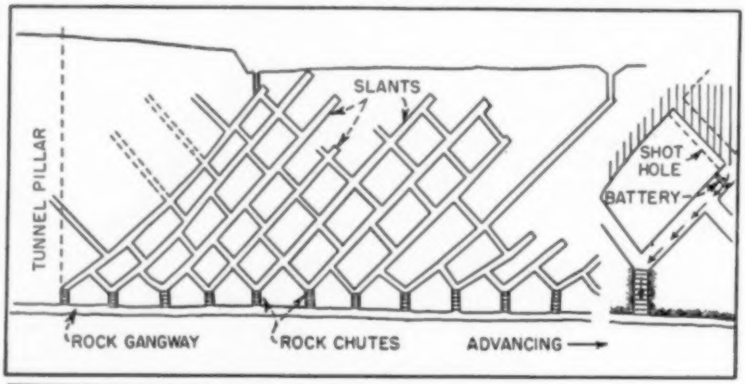
Light- and moderate-pitch plans also include the longwall system with ripper-type mining unit discussed in the previous section on "Longwall."

Heavy Pitch

Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have been only partly successful, though the introduction of longhole drilling is beginning to alter the picture substantially. It too, however, requires a fair amount of hand labor in driving



SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under the coal.



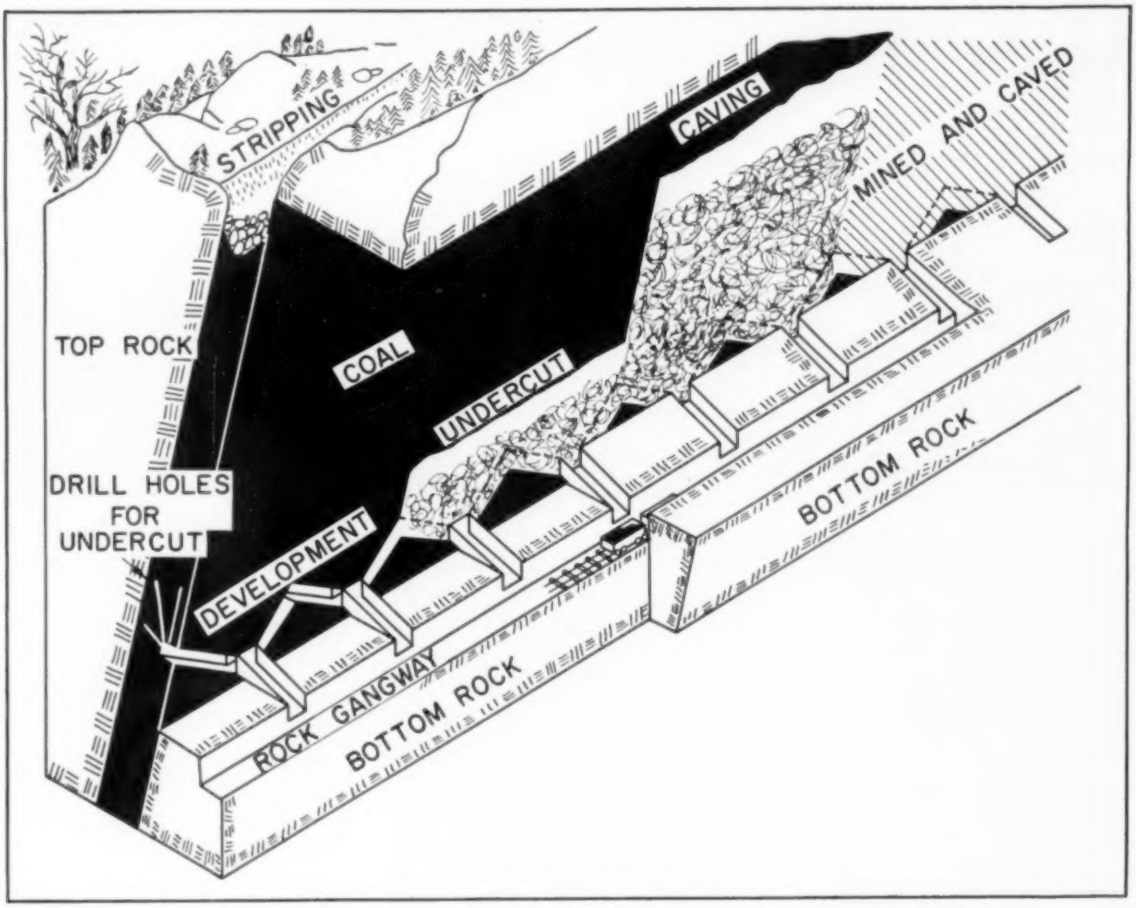
TWO LONGHOLE PLANS show (left) development along usual lines except that pillar size is increased to permit drilling and shooting, and (right) operating in nearly vertical vein with only drill headings in the coal.

openings for air and for preparing the sites and faces for longholing, though not as much as previous systems.

Initial longhole experiments go back over 20 yr in the anthracite region, with a lapse of over a decade after the first trials. Meanwhile, to alleviate the labor and difficulty of advancing breasts straight up heavy pitches, attention was concentrated on plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans were evolved, differing largely in details—for example, 30-deg openings, with sheet iron and without batteries in one "diamond" plan, compared to 45-deg openings, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down. Usually, one-third to half of the pillar is drilled with holes up to 45 to 50 ft, loaded with explosive placed with detonating fuse to insure complete detonation, and shot. The coal then flows to cars in the gangway, controlled as necessary by checks or batteries. In the slant-chute system a new battery normally is built immediately below each time a new section of pillar is shot.

Because life usually is long and disturbance in the vein can be substantial after mining gets well started, the trend is toward gangways in the rock under the vein, with rock chutes up to the coal. This leaves a strip of coal between the rock gangway level and the top of the rock holes. This strip may be recovered from the next gangway below, or short, level rockholes can be driven to the vein, which then is opened up by chutes as necessary and then drilled and shot into short conveyors leading back to the rock gangway.

Induced Caving—Another proposal for reducing labor in mining heavily pitching veins is "induced caving." Similar in principle to "block caving" in metal mining, the system has shown promise in its initial trial. The original idea, as developed by the Bueau of Mines, is shown in the accompanying illustration. It involves a gangway in the rock under the vein, rock holes up to the coal, slant chutes between rock holes in the vein, and undercutting of a section of the vein by drilling and shooting to induce caving, with the coal drawn off through the rock chutes as caving progresses up to the surface or the



ORIGINAL INDUCED-CAVING CONCEPT for mining steeply pitching anthracite veins.

old level, unless rock dilution becomes excessive. Production in the initial experiment was 33.5 to 38.8 tons per man-shift.

Longholing

Variations in longholing methods largely reflect how much preliminary development work is done. As an example, in moderate pitches, the conventional chambers and crosscuts may still be driven, the principal change being an increase in the size of the pillar left. The pillars then are drilled and shot instead of being mined in the ordinary way. Holes therefore are seldom more than 50 ft long. An example of plans where the emphasis is more on drilling of pillars formed along conventional lines is shown in the accompanying illustration along with an example of longholing with a minimum of development.

Longholing with minimum development at one operation, as an example, is based on gangways and airways in the rock beneath the vein, with rockholes to the vein at intervals fitted with batteries to control coal drawoff. Holes drilled back from the next rockhole and cased with pipe insure positive ventilation behind the battery both before and after shooting. Holes also are drilled to the next level above to drain off any water that may have accumulated.

Longhole drilling is done from a heading in the coal. To start a section, two places are driven up to the old workings and the chain pillars are removed to provide expansion room for the coal to be shot. Then the coal between two rock holes is shot by three groups of three holes each, one parallel to the bottom, one angling up through the vein and one directly toward the top rock. Firing is done on off-shifts or idle days.

Dos and Don'ts – Use close-fitting joints to prevent hole drift. Check to make sure any water above is drained out. Check to make sure no charges are set off in gas. Make sure detonation is complete to eliminate possibility of burning explosive igniting coal. Clean holes thoroughly. Use plastic-type explosive and keep quantity per load down to avoid spreading of lower stick in charging. Arrange for positive ventilation with good control at all times. Make all openings used for drilling large enough for comfortable, convenient operation.

Boring Crosscuts

One of the more aggravating and expensive items in gangway development in coal in moderate to heavy pitch mining is crosscutting between gangway and airway. The big drill is one answer. Size may range from 24 to 42 in, and one, two or three holes may be drilled up the pitch to get the required crosscut area. In contrast to an earlier version (*Coal Age*, May, 1951, p 100) a new and much-lighter type (*Coal Age*, August, 1955, p 58) employs a hoist and rope to pull the big bit through a pilot hole. Another advantage of the bored crosscut is that a simple disk rather than an expensive custom-made stopping can be used to close it.

NEW AIDS TO HIGHER EFFICIENCY in face preparation include (top left) the flexible-shaft drill operated from power takeoff on cutter and (top right) the hydraulic hand-held drill receiving power from cutter hydraulic systems or special pump. Hydraulic positioning and auger operation also feature high-production rubber-tired drilling unit at left.

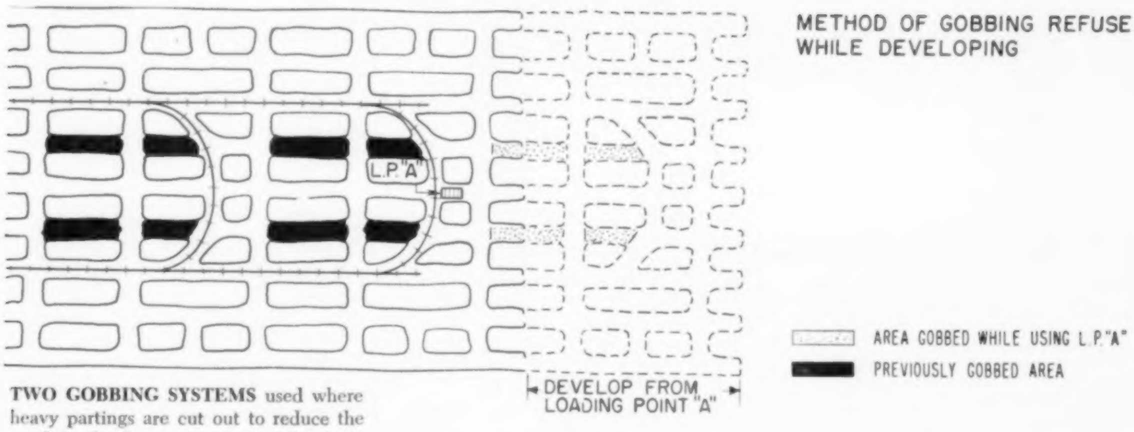
Face Preparation

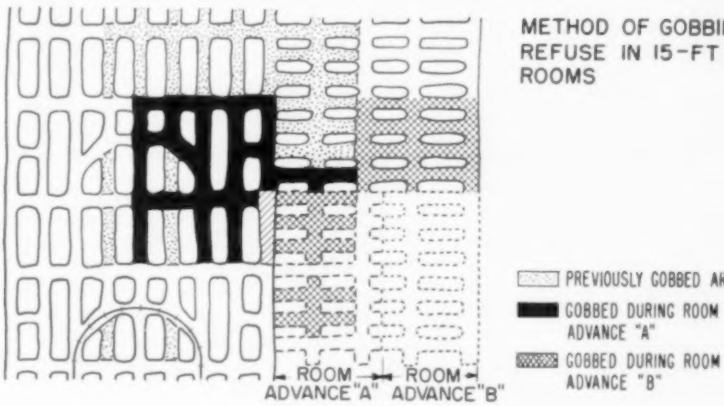
MAXIMUM RESULTS in face preparation are attained only by constant study of cutting, drilling and shooting, including equipment, bits, placement of cut or cuts and placement of holes. The goal is maximum output by the loading unit, whether man or machine. When this is attained, tons per man engaged in face preparation is higher, expenditures for explosives and detonators are lower, and safety is advanced.

Bits—Both their own cost and their effect on productivity, plus, even, their effect on the size consist of the coal, make bits important. Sharp bits of the proper type, for example, can make a noticeable difference in realization by decreasing the percentage of extreme fines. They also reduce the power consumption in cutting.

Under some conditions, the old carbon bit, forged and quenched, can give a good account of itself. However, these situations are growing fewer, and the need for greater capacity with fewer interruptions for replacement and sharpening has resulted in the development of throw-away, hardfaced and carbide-tipped bits for both cutting and drilling. They sometimes run for days before changing and resharpening are necessary. Some designs can double in brass—for example, drilling first coal and then drawslate where it is taken down for height or for safety; or cutting in either coal or partings if required.

Aside from the desirability of keeping all possible metal out of the coal, insert-type bits cost considerable money in themselves. The rule, therefore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each cutting, drilling or continuous-miner crew—or at least in each section—supplemented by regular inventories will help keep down losses. Grinding to restore bits to service con-





TWO GOBBING SYSTEMS used where heavy partings are cut out to reduce the need for hauling refuse material outside and disposing of it on the surface. One system is used in heading advancement and the other in room work.

dition also can materially affect cutting qualities and the total number of regrinds, meaning service life. Manufacturer's recommendations should be the guide.

Cutting

THE SHORTWALL and the rubber-mounted universal machine are the predominant cutter types today, with the latter accounting for more and more of the total tonnage because of flexibility, greater mobility and higher capacity. The shortwall, however, still dominates in conveyor mining, particularly in thin coal, and also is a part of mechanical units in thick coal at a number of mines. Hydraulic tilting makes it easier to use and adds appreciably to capacity where the cycle is tight. Bugdusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cuts and generally improve loadability.

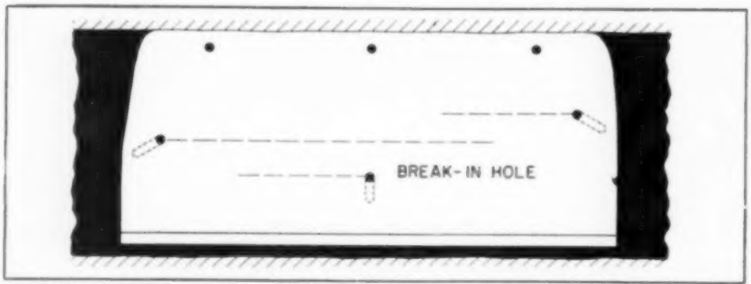
Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, however, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding. If they replace shorter bars on an existing machine, care should be taken to make sure that the motor can carry the extra load, either as is or with improved insulation.

Cut Positioning

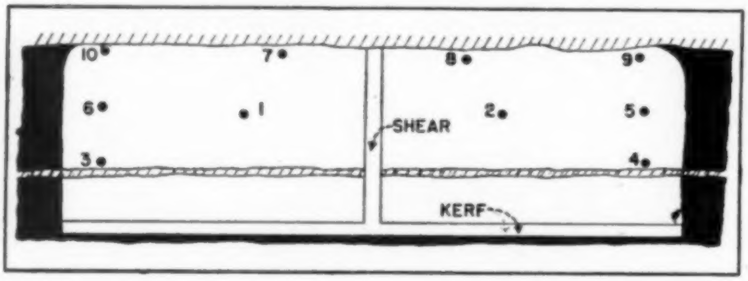
Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief so that most of the remaining material can be raked out.

Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material. However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or drawslate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower over-all cost.

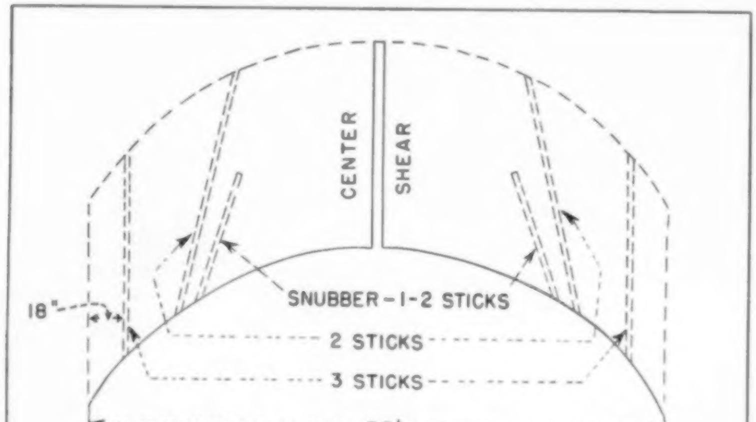
Special goals in cutting include adjustment of undercutting, where the bottom is soft, to provide a good coal pavement for the operation of shuttle cars and other equipment.



BREAK-IN HOLE provides additional free face for succeeding holes. In this plan, rib holes are stepped up to break lower part of face in sections.

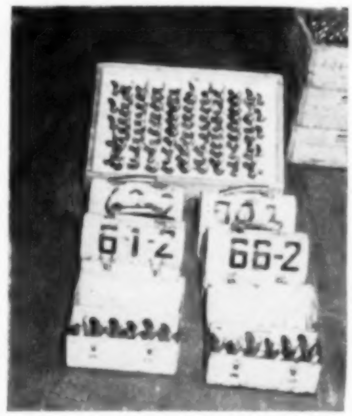


EQUALIZED BURDEN is the goal in this drilling pattern in a center-sheared place, thus achieving good breakage of both coal and impurity band with a minimum expenditure of breaking medium.



SHORT SNUBBERS break band and roll out the front of the fall in arc-cut center-sheared working face. Shearing and snubbing reduce the number of holes required and also cut explosive requirements to a minimum.

PROTECTION against damage or loss is necessary with modern drill and cutter bits. Upper photo shows locked cabinets, one for each section. Lower shows wooden bit holders placed in lunch boxes carrying section numbers.



SAFETY ACCESSORIES include galvanometer to test circuits in millisecond delay shooting.

Shearing

The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust. In permanent headings, some operators have sheared both ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one—usually at the side in headings or other narrow openings, and between one-third over and the center in rooms. Partial shearing, say in the bottom bench, has been done at times, either to reduce the production of cuttings or to avoid, for example, a high-sulphur top band.

Drilling

DEPENDING upon conditions and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also hand-held, post-mounted and mobile units. The latter may be designed with one or two arms, with hydraulic auger drive now coming to the front for greater capacity and flexibility. Hydraulic drill-positioning frequently can release one man from the crew for other productive work.

Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic takeoff are among the secrets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

Augers—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Shooting

A WIDE RANGE of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbon-dioxide, air and chemicals, all basically relying on building up pressure in a tube against a disk which ruptures at a certain limit to release the gas or air and break the coal. Air is the most-used non-explosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semiportable units underground at strategic points.

As a rule, carbon-dioxide, air and chemical breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden.

To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

Hole Placement

Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, with the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

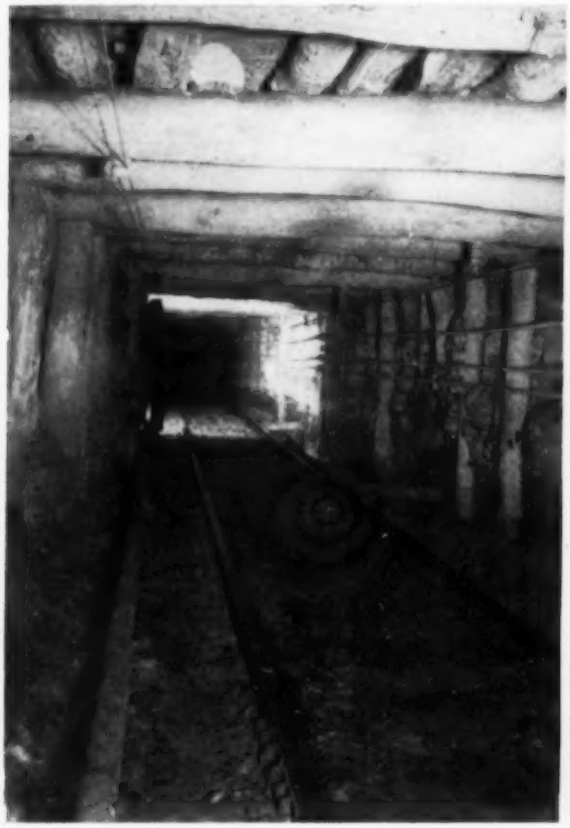
Concentration may be sought for or avoided. As an example, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium strung out over more of the hole.

Charging and Firing

Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives. Time saving in acquiring, distributing and applying stemming material is one of the benefits.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing charges, less shock to the roof, and much less exposure hazard for the shotfirer.

Aside from charging and firing responsibilities the shotfirer or shotfiring crew necessarily must transport tools and supplies. This problem is considerably eased by some form of wheeled conveyance. A child's red wagon, as an example, is extremely useful for this purpose, especially in thin coal.



THREE-PIECE SET is the old-reliable in permanent support with timbers. Treatment materially lengthens life.

HITCH TIMBERING eliminates legs. Lagging and cribbing protect top in this pin-and-stringer version.

Four Basic Permanent-Support Systems

STEEL LINING protects opening in soft ground. Other Linings include concrete and sand-cement.

YIELDING ARCH for unstable ground can be made of steel, as in this installation, or of concrete sections.

Temporary Basics . . .

SAFETY POSTS OR JACKS at the face and posts, or posts and crossbars, behind them are old-reliables.

ROOF-BOLTING is latest in both temporary and permanent support. Here, bolting is concurrent with advance.

Roof Control

ROOF SUPPORT is required in coal mining for two reasons:

1. Protecting men—and facilities—from falls, crushes, bumps and other top, face and rib failures.

2. Keeping working places, including entries, open for the desired length of time, which may range from only hours in pocketing through a pillar with a continuous miner up to as much as 50 yr or more for entries and airways in especially long-lived properties.

Achievement of these two primary goals also means achievement of certain collateral objectives, including:

1. No interruption of haulage, travel and other operations. Obviously, a heavy fall on the main line can shut down a mine completely, aside from the cost of cleaning up and timbering or retimbering. Even with light falls there is a penalty which, if falls occur with some frequency, can total a considerable sum in the course of a year.

2. No blocking or partial blocking of service openings, such as airways and drainways.

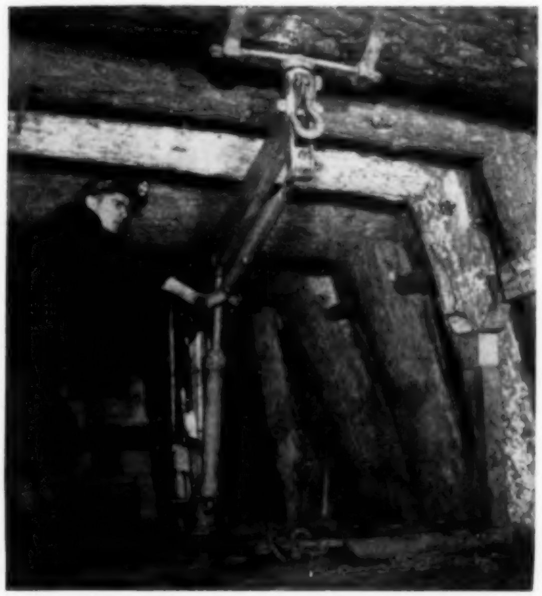
Roof Action

SUPPORT varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, with another type where both the drawslate and all the overlying material must be held, and still others for permanent openings in bad top or caved ground. Weathering as a result of changes in temperature and moisture content of the ventilating air may warrant sealing the top, which is "support" in another guise.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines. Among them are:

1. Falls of Immediate Top—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the

MOBILE TIMBERING MACHINES cut cost of adequate face support while facilitating adherence to standard plan.



HAND-PUMPED HYDRAULIC LIFTER here eases job of replacing heavy set. Truck mounting facilitates movement.

question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or capboards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semipermanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top, is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in the process of installing permanent support.

2. Rib and Face Falls—An alternative form is sloughing, which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example—such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. Squeezing—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, proves to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal. Most old-timers maintain that once a real squeeze started nothing would stop it until settlement and readjustment were complete.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. One of the effects and one of the several hazards is the ensuing air blast which, in the magnitude sometimes attained, in addition to wrecking doors, stoppings and other structures, can knock cars off the track and throw people around sufficiently hard to cause severe injury or death. Preventives include ample pillar area and careful attention to getting initial breaks quickly.

4. Bursts or Bumps—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The basic line of defense, however, is adjustment of the mining plan to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conducive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the shorter the period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be

avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment or stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. Intentional Caving—Since caving relieves the remaining coal of weight—at least in substantial measure—and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occurs. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick. Where subsidence is limited by packwalls or some other form of support, the initial strata may be cracked as a result of bending in the slow subsidence but falls of the type encountered in complete caving are relatively infrequent. Also, roof action, aside from a gradual and limited subsidence, seldom extends to the surface.

Timbering

TYPES OF SUPPORT in the "timber" classification range all the way from roof jacks at the face to steel, concrete and brick linings in permanent openings. Between these limits, timber includes posts, legs and bars of wood, steel and aluminum; yielding arches and rings of reinforced concrete and steel; concrete, brick and masonry columns, piers and abutments; such supplementary items as wedges, capboards, headers and lagging; and coal itself. Other forms of support, in addition to timbering, are bolting, and coating and sealing, discussed later in this section.

Permanent Timbering

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example), it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down.

As an example of "permanence" which is not permanent, consider the case of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement normally more expensive than the original. The moral is that within limits it is better to spend more at the start for permanence, not only to eliminate replacement, and also production stoppages as a result of falls, but to keep routine maintenance as low as possible. When timber is installed so that it doesn't rot, fail under load, or permit sloughing and spalling, as examples, conditions are most favorable for keeping maintenance to the bare minimum.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an extreme example, it would be wasting money to line a 5-yr-life opening with reinforced concrete, though a sand-cement mixture an inch thick on wire might well be the thing for this particular application.

Lining—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, the coating is only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in, they provide some holding power in addition to sealing. Steel liner plates also provide sealing with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

Grouting—Though not strictly lining or coating, grouting has been used to strengthen top in sections of permanent openings under, for example, stream beds where the overburden is thin and the top is rotten. Elimination of water seepage may be a secondary goal. Sometimes it is the major one, with strengthening of the top as a collateral benefit.

Piers and Abutments—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

Yielding Arches and Rings—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the ground in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest in the U. S. (*Coal Age*, April, 1954, p 92) is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

Three-Piece Sets—Probably the widest used of all forms of permanent timbering, the three-piece set—a crossbar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If steel legs are

TIMBER RECOVERY is facilitated by power winches mounted on crawlers or built onto gathering locomotives.

BOLT RECOVERY usually employs hand tools. Safety posting is essential, and men should work in pairs.

operating interruptions, and most of the cleanup expense. The possibility of such falls is the major reason for emphasis on ample timber installed according to a fixed plan, and on the use of safety posts, jacks and bars in the face working area.

One question with thin, relatively weak roof layers over the coal is: "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the used, they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other is held on a leg.

Hitch Timbering—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regular bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

Lagging—Spalling of top and sloughing of ribs are the reasons for the installation of lagging, which may be small natural round timber or sawed material. In long-lived openings, lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose roof material in place.

Single Posts—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

Coal—Coal itself is widely used as a means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution.

Temporary Timbering

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. **Protecting men.** The average dimensions of roof falls resulting in fatalities is given by the Bureau of Mines as: length, 10 ft; width, 9 ft; thickness, 1¾ ft. The majority of these falls (60%) occur in the face area inby the last permanent support, and 95%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. **Keeping workings open.** The aim here is to preserve access to the face area from which production comes.

3. **Holding top during pillar removal.** Here, the support should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

Standard Plans—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with additional support where there is any doubt that the minimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

Face-Area Support—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unknown. Among the specific hazards are slips, clay veins, kettlebottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively as mining moves toward mobile machines. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, crossbarring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

Face support plans are almost infinite in variations but the general routine is to extend posts or crossbars to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting, the top may be caught by safety posts or jacks as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

Protection for loader and miner operators, who are relatively far back from the face, commonly is provided by crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place, moving them ahead when each cut is completed.

Pillar Support—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered, and even if it is not, it represents a support cost considerably less than the conventional timbers or cribs. Artificial support, as in solid work, consists of jacks, posts and bars used much the same way, plus cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks. Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone. At another property, the machine operator is protected in recovery of the final corner stump at the intersection of the pillar split and room by erecting cribs on each side of the space in which the machine advances in mining the stump.

Room and Room-Entry Support — Depending upon equipment and mining plan, "permanent" room and room-entry timbering starts at from one cut up to 25 ft back of the face. Usual types are posts with or without capboards or short headers, and three-piece bar-and-leg sets. With topcutting in thick coal, legs may be eliminated by gripping out with the bar to form slots into which the bars may be slid.

Timber Economics

If a place makes 25 tons and a post costs 75c to buy and the same to install, the cost is 6c per ton. Therefore, particularly where no recovery is contemplated, support methods, materials requirements and possible recovery should receive intensive study. Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since even saving one post per cut amounts to considerable money per ton, a change in the posting pattern—perhaps by staggering, as an example—can achieve this saving and still provide the requisite support and protection. Where bars and other more-expensive items are involved, the desirability of close study and economy becomes even greater.

Timber Installation—Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines, now available in a number of types with both rail and rubber-tired mountings. The first commercial design for a timbering machine was developed around 10 yr ago, and one of the first installations saved its user 12c per ton in reduced labor for timbering and higher tons per loading-machine unit.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of crossbars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

Even without special machines, the timber crew's work can be lightened and its capacity increased by the use of timber jacks to take the manual labor out of raising crossbars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

Salvage—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed,

but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a remote and safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated post-puller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks. Even with the best of equipment, recovery is only a fraction of the total timber installed, though a sizable one in many instances, with consequent over-all reduction in cost of posts and bars. In some instances, posts and bars have been reclaimed and re-used as many as five times.

Roof-Bolting

BY THE END OF 1956, the proportion of bituminous coal mined with roof-bolts will approach 50%. This reflects, among others, the following advantages:

1. **Better support** and consequently fewer injuries and fatalities from falls. According to Bureau of Mines, it is 5½ times safer to work under bolted top, compared to timbered. One reason is that bolting lends itself better to the development of definite patterns, and to closer adherence to the patterns after development. Clearance—either side or top—is not reduced in bolting, and there are no timbers to be knocked out.

2. **Higher output** per man and machine as a result of more working room and no interference.

3. **Less bulk in support material** to be stored, handled and transported.

4. **Better coal cleanup.** In some instances, loss of coal behind timbers is as much as 5% of the total or more.

5. **Higher extraction** as a result of good top conditions and fewer or no falls throughout life of place.

In some instances, all these advantages—or many of them—have been secured with an actual reduction in support cost as a result of bolting. Normally, however, bolting cost, everything considered, is slightly higher than conventional timbering, but is warranted because of the advantages enumerated previously, as well as others.

Bolts broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. In addition to the usual steel bolt, wood pins are being used to a limited extent for the same purposes, i. e.: holding top and stabilizing ribs. Bolts, however, are not a universal cure-all for roof troubles, and conventional timber may be better from all angles under certain conditions.

Bolt Types

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This, it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchor stratum must be found, other means of support normally must be employed.

Split-Rod-and-Wedge—Properly installed in rock of the right type, load-carrying characteristics of the split-rod-and-wedge bolt are excellent. It is easy to install and is not weakened in the installation process. However, it requires compressed air for driving and thus may require the purchase of compressor equipment. The extra step of driving the bolt into the wedge increases installation time approximately 20%, and cost of materials usually is higher. It loses its holding power more readily in the softer, semiplastic rocks and protruding bolt ends are a hazard, though they may be clipped with special bolt cutters.

Expansion-Shell—Requires no driving to anchor, is better suited to softer semiplastic rocks, is normally cheaper—about 25%—and can be installed in shorter time. However, it is more difficult to tension properly, and maintenance of tension is difficult in soft material.

Usual bolt size today is ¾ in. Tightening to a torque of approximately 150 ft-lb will develop a tension of 8,000 to 10,000 lb, or approximately 75 to 80% of the yield point of the usual mild steel in pure tension. With the development of high-strength bolts, the use of ⅝-in units is expected to become general, since the cost is 10 to 15% less. Safety authorities, however, warn against tensioning past the yield point, and also against any increase in strength which would render the bolts brittle.

Bolting Patterns

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute to holding power and safety.

Auxiliaries, however, are a necessity under certain conditions. For example, if the roof is tender or contains slips, cleavage cracks, kettlebottoms, and the like, wood headers or crossbars on the bolts, including steel channels or ties (sometimes with wire mesh) in permanent openings, are as much in order as if posts or legs were being set. Mixed bolt and timber plans, as a matter of fact are fairly common. For example, though bolting can result in compacting the roof members, it may not provide a beam with all the strength necessary, especially over the longer spans. However, it does provide a great deal of the required holding power and makes the conventional timbering less complicated and costly, in turn reducing the over-all cost of the entire support job. Also, since bolts do not show subsidence, posts may be installed in pillar places as indicators of weight and convergence, aside from providing backup support in final recovery operations.

Mixed patterns also include, as an example, installing crossbars in pillar splits with legs on the gob side and bolts on the solid side. Bolting provides more room in the split for working, while the legs become part of several breaker posts set under each bar to hold the top during mining of the next split.

Where bolts are used alone, a check of published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts. Special patterns for long spans or weak top include the "star" (a bolt in the center of a four-square pattern). Also, under some conditions, making

part of the bolts—say every other one—longer may be helpful.

Bolt Installation

Split-rod-and-wedge bolts require a percussion tool for installation, which in turn requires compressed air. Since bolts of this type were the first to be developed, air was the first bolting medium, being used both for drilling and driving.

Air still is the preferred medium for drilling the hard rocks encountered in mine roofs, even though electric rotary drills have been taking on harder and harder material. Portable compressors are widely used, though central stationary units have their advocates, who state that the advantages include plenty of air at rated pressure, lower maintenance and less trouble with dirt and water in air lines. Portables may be mounted on rubber or crawlers, or may be carried in shuttle cars. They may be sized to operate one or two stopers, but in any event they should be capable of supplying drilling needs without drop below rated pressure.

Development of the expansion-shell bolt put the electric drill into the bolting business and now a wide variety of units are available. At the same time, rotary drills have been put into harder and harder material, though they still cannot cope too well with extremely-hard types. Experience has indicated, however, that reducing rotational speed and building pressure up to a maximum results in better footage in hard cutting. Sharp bits also speed penetration, and reduce the other ill effects of a lower rate of penetration in hard material, i. e.: faster bit wear, shorter bit life and higher drilling cost. And where bithead design is such that high penetration rates are possible, higher drilling pressures yield better results.

Of the two main methods of suppressing dust—water during drilling and dry collection—the latter is forging ahead because of the inherently greater complications of water. The simplest form of dry collector consists of a flexible collar held against the roof to collect the cuttings and drop them into a bag or onto the floor. More positive means of collection and disposal are provided by vacuum units operating through collars around the drills or, in the latest, by pulling the cuttings through hollow bits and drill steel.

Concurrent Bolting—Continuous miners, since they stay in one place, have presented some problems in attaining the benefits of bolting. Until recently bolting normally required stopping the miner at least for drilling. A long step toward solution of the problem resulted from the mounting of two hydraulic drilling and bolting units on the miner—one on each side immediately back of the timber jacks (*Coal Age*, April, 1954, p 102). With these units, two men drill two 5-ft holes and place two ¾-in expansion-shell bolts and wood headers in the time it takes the miner to cut across the face. As a result, the available working time for the miner was increased 15%. Since the bolters can be swung 30 deg, the bolts in the two rows on each side of the place can be staggered for greater coverage.

Bolting Dos and Donts—Check hole size and avoid overdrilling as a result of worn bits, whip and the like, especially in soft material where maximum holding power is a necessity. Diameter gages are a convenient means of making such checks.

Where expansion-shell units are employed, check plug and shell position periodically by removing sample bolts to insure that bolts are properly anchored.

Use caution with wood headers to make sure that bolt tension is preserved. Wood can dry out, yield under pressure and otherwise change characteristics with consequent loss of tension. Never install a wood header or crossbar with nut alone. Always use steel bearing plate.

Check tightening torque carefully. In hard material, up to 200 ft-lb may be employed. In soft material, under 150 ft-lb may be advantageous. Bolt-tightening equipment should be checked with a torque wrench.

Check tension on bolts in key areas occasionally, since relaxation for a number of reasons may have occurred. Retightening may restore tension or replacement may be desirable.

For a fuller discussion of questions involved in bolt installation, see *Coal Age*, June, 1954, p 98.

Bolt Recovery—Since, as with timbering, except on pillar lines, it is estimated that not more than one bolt in 10 is ever called upon to actually support top material, salvage almost automatically becomes a matter for consideration, since whether the bolt is holding top is a major factor in determining whether recovery is possible. Even if most of the bolts were supporting top, salvage would still be possible by installing protective support, but the hazards are substantially greater and the savings possibilities correspondingly less.

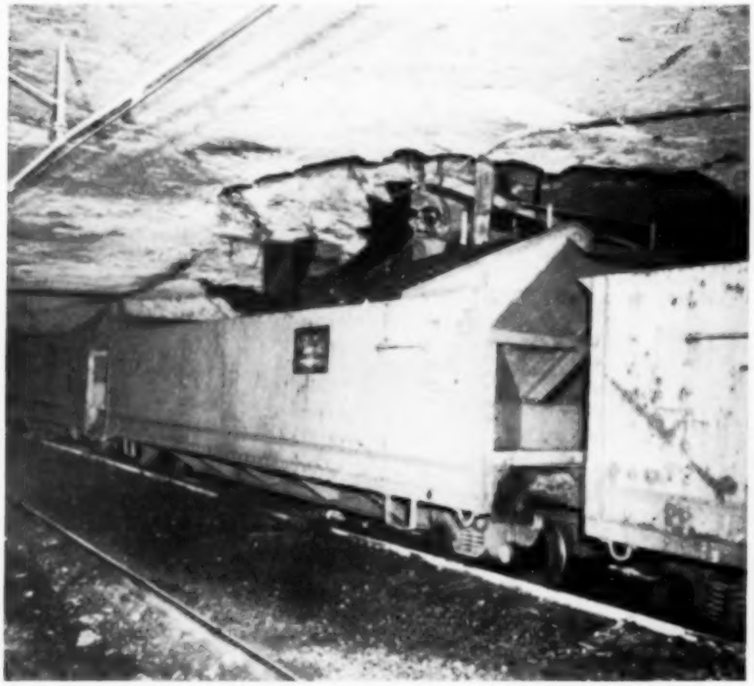
Recovery operations so far are limited almost entirely to the expansion-shell type of bolt. Under favorable conditions, recovery cost is ¼ to ⅓ the cost of a new unit, including expenditures for new shells and nuts to go with bolts and plates that have been salvaged. Hand salvage is the rule, and a basic principle is setting roof jacks or safety posts before any attempt is made to remove a bolt. A second principle is at least two men to a salvage crew, since two heads can be better than one in guarding against hazards, and the second man, in case of trouble, can, in many instances, prevent an accident from turning into an injury or fatality. Experience so far indicates that a two-man crew can recover 200 to 300 assemblies in a shift.

Coating and Sealing

THE SUSCEPTIBILITY of certain types of roof to changes in moisture and temperature is so pronounced that a number of deep mines in the past have installed elaborate conditioning units to insure uniform humidity and temperature. More recently, even though the idea is old, a number of operators have turned to coating and sealing to prevent roof and rib deterioration as a result of these influences.

Coating and sealing products include vinyl compounds, coal-tar products and mastic-type materials—all sprayable with or without heating, usually because they are dissolved in a volatile compound which evaporates after application. Because solvents normally are flammable or explosive, or both, care must be taken in application. Also, care must be exercised to see that after application the material will at least not propagate fire even if ignition cannot be prevented. A number of products now on the market meet this standard.

Careful scaling and dryness are major prerequisites to good sealing. Though it provides no support, sealing has cleaned up some very-costly roof and rib disintegration situations at a number of mines where conventional timbering failed to do the job. Cost varies from 15c to 20c per square foot minimum at most operations, including scaling and other preparations. Usual practice is to seal the top and carry the coating 6 or 12 in down each rib for insurance. At some mines, all the coal ribs are sealed to prevent sloughing. One of the incidental benefits is a smoother surface, which helps ventilation.



AUTOMATICITY IS THE KEYNOTE in haulage developments as in other coal-mining operations. Here 25-ton cars are being loaded automatically by a mother belt, with the assistance of overlapping car ends and switches actuated by rollers and ball-type coal floats.

Transportation

THE FUNCTION of transportation is to move coal from the face as fast as the loader can load it or the miner can mine it, and keep it moving to the preparation plant on the surface without interrupting loading or mining. This means that the transportation system should always be in place and ready to carry coal anytime loading is in progress. Furthermore, the system should have capacity to handle any peak the loader or miner is capable of reaching. Finally, the system should operate with a minimum of manpower and maintenance.

Face Haulage

ALTHOUGH MINE CARS have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no farther back than the next crosscut, and at the worst no farther than 150 to 175 ft back. One contribution to the short change with cars was the development of prefabricated track layouts, which practically guaranteed a changing point at every crosscut.

Track condition has a real and substantial effect on car-service efficiency, not only in rooms where loading directly to cars is the practice but also even in panel-entry operation with shuttle-car or conveyor haulage in rooms. Heavy rail—up to 50- to 60-lb—is one assurance of good track in panel entries, where 40 lb is about the lightest that can be tolerated with big cars and locomotives in keeping with such cars. Steel ties and prefabricated steel-tie turnouts naturally cut cost of installation and removal to a minimum. Throws on turnouts, among other things, considerably reduce the development of situations leading to derailments.

Shuttle Cars

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

Surge Cars, Pickup Loaders—The relatively low capacity of the early continuous miners quickly brought out the fact that the intermittency of shuttle-car service, even with the best of setups, was a considerable handicap.

Among the steps to offset this handicap is the establishment of storage or surge capacity between miner and shuttle car. The mine bottom is one form of storage, in turn bringing in the pickup loader. Even with the cost of the loader and operator, the increase in miner performance has been sufficient in many instances to show a handsome gain.

The surge car is a possibility under some circumstances but is not a cure-all. The car may be a standard shuttle car or a specially built unit. Whether to use a surge car can be determined only after a careful study. Among the factors that militate against their use is large shuttle cars and a short changing distance. Also, as miner capacity increases, the situation becomes more like machine loading, where the capacity of the face unit in tons per minute is so large that some delay might be tolerated, even though it sets a dangerous precedent. If miner capacity is low, or if changing distance is long, a surge car of the right type can be a help.

Haulage Limits—The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit. This may be offset in part by introducing a third car, which, however, requires extra investment in equipment and labor, and very careful organization of the haulage system to prevent interference. However, some operators use the third car quite successfully.

The cable-reel limit can be stretched by anchoring the cable at the midpoint and backlashing on half the run. Some operators who have tried it recommend against the practice not only because the long hauls raise loader waiting time, but because backlash reeling is more difficult and is harder on cable, guides and reel. Therefore, usual practice is to anchor at the discharge point. Shock-absorber-type anchorages are great cable savers, incidentally.

Though the ultimate savings at any particular operation depend upon the mining plan and conditions, the possibilities in keeping shuttle-car distances short may be substantial. For example, extra moving of transfer stations to keep distance down by 200 ft per round trip might cost, say, 1½c per ton, while the reduction in face cost as a result of higher machine output might be 10c. Separate travelways, where possible, also contribute to speeding up shuttle-car service and thus increasing face output.

Transfer to Mine Cars—In addition to rubber-tired and crawler mountings, shuttle cars now are available in four-wheel-drive-and-steer types; with right- and left-hand drives for greater convenience in operation and in anchoring and reeling cable; and with elevating discharges. The ability of the four-wheel-steer and crawler machines to negotiate 90-deg turns, incidentally, has been in part responsible for a swing away from angle development back to the old-reliable square systems. Dynamic braking is available where loads are consistently moved down substantial grades.

Unless the track is sunk, an elevator is necessary for transferring from standard shuttle cars to mine cars. Sinking is done at some mines, and normally where this is the practice an effort is made to have one station serve places in both sides of an entry. The same practice also is followed where the top must be shot to permit the use of elevators. To keep the shuttle-car haul down to the minimum, stations normally are established at intervals of 200 to 300 ft. And also to reduce top-shooting as much as possible, at least one operator has developed a low-type elevating unit mounted on a crawler-type mining machine truck (*Coal Age*, September, 1955, p 72). A high-speed conveyor is provided to eliminate slowing down or stopping shuttle-car discharge. In this instance, transfer stations are prepared by the development crews every 120 ft.

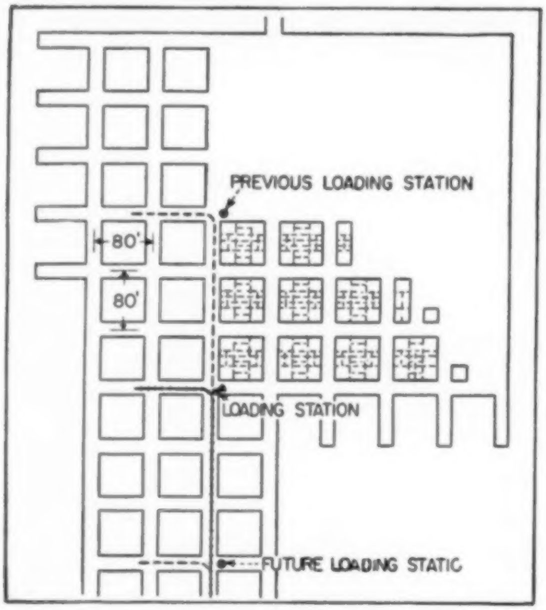
Making it possible for the shuttle car to discharge at maximum rate without stopping is, as noted, a major element in keeping an operation tuned up to maximum efficiency. If elevator capacity is low, a hopper should be provided—usually by sinking the boot into the bottom. Or the chain should be speeded up. Provision also should be made for changing mine cars without stopping the elevator or shuttle car. Making shuttle-car and mine-car capacity match is one method being used at new mines or where cars or shuttle cars are being replaced. This method is especially effective with elevating-discharge cars, but works well with any other type of transfer equipment.

Transfer to Belts—A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts. Where side loading is practiced, with the belt in the center of three headings, it is possible, by assigning a crosscut on each side to a shuttle car, to load at four points, provided the crosscuts are offset. Also, with two cars, one may be assigned to the end position and the other to a side position in the next crosscut down to keep them apart at all times. In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary.

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward. Transfer conveyors capable of taking maximum shuttle-car discharge and at the same time designed to feed to the belt at the proper rate are used at a number of mines. They may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and overloading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83). When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically. Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt from pouring coal onto an already loaded main belt.

Shuttle-Car Roads—Ruts, dust and mud are the major difficulties in building and maintaining shuttle-car roads. A good rut preventive used at many mines is to sling a section of light rail or angle crosswise underneath the cars and just clearing the bottom using chain or wire rope. The constant scraping action tends to keep roads smooth and prevent the formation of ruts. In dry mines particularly, calcium chloride keeps down dust and also tends to help the tires roll out and compact the bottom



SIMPLEST TRIP LOADING is tail-track system. Here, track is turned 90 deg through crosscut.

into a good running surface.

Where there is much mud, planking is the usual answer, normally with 2x8's or 2x12's on stringers of the same material under the tire tracks. Spaces of, say, 3 in between planks reduce the number necessary and also provide places in which to lay cables serving other machines that might use or cross the roadway.

Tire and Tire-Filling—Water filling of shuttle-car tires is now widely accepted, though some contend that water should not be used at shuttle-car speeds. Lately, the solid tire has challenged the pneumatic type. Advantages include longer life, higher shuttle-car travel speeds and no failures (*Coal Age*, May, 1955, p 95).

Battery Tractors

Rubber-tired trailers or trailer trains pulled by battery tractors are among the developments and modifications of the original shuttle-car idea. They were developed primarily to meet the problems of the small drift mines in coal under 36 to 40 in, with some in 24 in or less.

Before the train idea was evolved, a number of designs for a low-cost shuttle car for such operations had been developed (*Coal Age*, April, 1953, p 88; July, 1953, p 88; February, 1954, p 116; June, 1954, p 101). Built with automotive axles and certain other automotive parts, the earliest such units usually had a capacity of less than 1 ton and were designed for hand loading. The usual motive power was a single-phase repulsion-induction motor with automotive-type transmission. The trailing cable, up to 1,000 ft in length, was dragged behind the unit. In later models, capacity was increased to 3 tons to permit use behind loading machines, and DC power was employed. Also, tractors were developed for pulling bottom-dump trailers. In all instances, the units operate all the way from the face to the dump outside.

The battery tractor is used to pull up to 10 trailers (*Coal Age*, May, 1955, p 99). It acts like a gathering locomotive also functioning as a mainline haulage unit. Both three-wheeled and four-wheeled trailers with lift endgates are used, and after the tractor pulls the trip to the outside it usually backs the cars one by one to a gravity dump, though dumping is done by hand on occasion. Hauls up to ½ mi have been handled by equipment of this type.

Conveyors

Since the conveyor is designed for continuous operation it is logical to consider it for all phases of haulage, including in rooms. In addition, the conveyor can work in low seams without taking top or bottom. Therefore, it finds wide application in thin coal because of both continuity of operation and low height, particularly where hand loading is the practice. The advent of the duckbill, sawbill and similar heads also provided the further advantage of converting the shaker type into a loading machine as well as a transporting unit. And to reduce moving time and labor, at least one crawler-mounted conveyor head is now on the market.

Bridge Conveyors—Continuity of operation also made the conveyor an attractive possibility for use behind loading machines. However, capacity in a practicable-sized unit is relatively limited, and keeping the tail boom in proper position over the conveyor is a time-consuming chore. As a result, conveyors made little headway in serving loading machines until the advent of the bridge unit. By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face. A typical bridge-plan appears on p 22 of this issue.

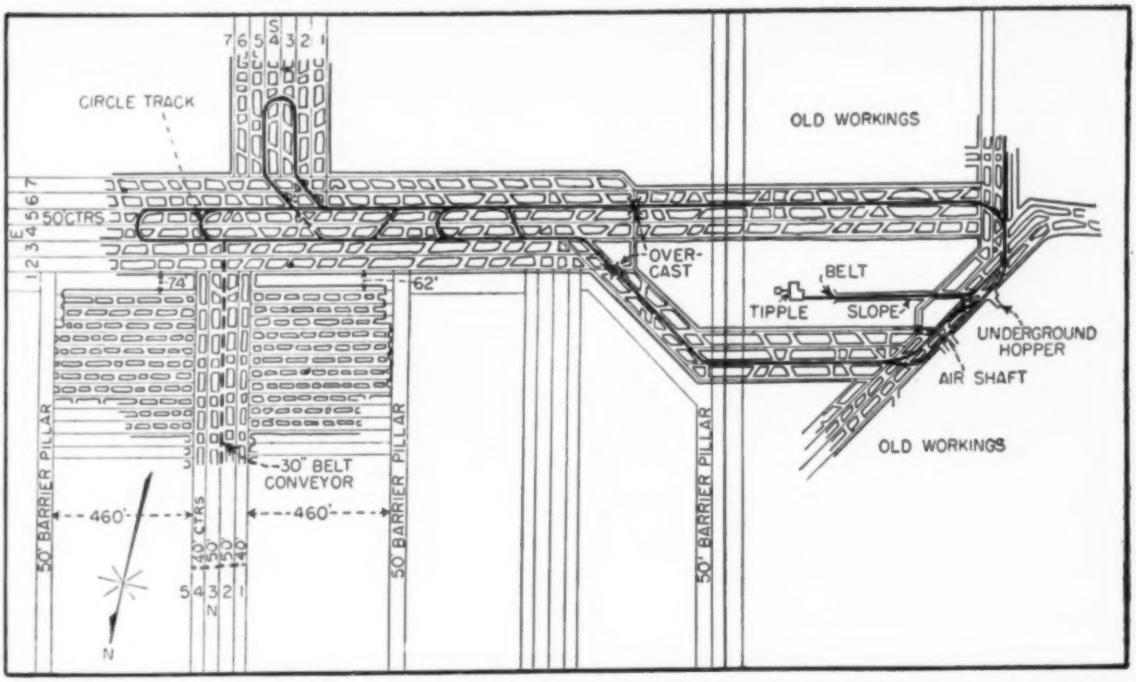
Evolution of the bridge unit has included development of the tandem bridge. Full discussion of the use of the tandem bridge in continuous mining under a variety of conditions appears in *Coal Age*, February, 1954, p 92.

Articulated and Cascade Conveyors—Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January, 1954, p 64). It is capable of advancing up to 1,000 ft simply by propelling itself ahead as the miner proceeds. It requires, however, a place for storage of up to almost all its entire length when places are breaking away. This storage may be outside in the pit in working from the outcrop, or down the heading in driving rooms underground.

The cascade system is substantially similar, but has some differences. One is in the fact that the conveyors need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system.

The Extensible Belt—Newest in the list of conveying-type equipment for face service is the extensible belt, which also makes use of a bridge conveyor to provide a continuous conveying route from the solid coal to the main line (*Coal Age*, June, 1954, p 88; October, 1954, p 96; July, 1955, p 50). It is designed to permit a miner to advance up to 1,000 ft, if desired, in one place without any operations other than adding stands and belt. Sections of belt and stands 100 ft long, permitting advances of 50 ft, usually are added in less than 5 min. Plans for taking pillars with extensible belts include the one shown on p 21 of this issue.

As an example of results with extensible belts, one



TRIP-LOADING PLAN shown here involves circle tracks around the belt heads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.

mine listed among the savings the elimination of six surge-car and six shuttle-car operators per working day of three shifts. Two extensible belts feeding to a panel belt were installed. Other advantages included: including elimination of many mechanical and electrical delays, as well as many shuttle-car hazards resulting from hauling under steel timbers. Also, there are fewer ventilation interruptions.

Adding a 100-ft roll of belt for a 50-ft advance take two men 3 to 5 min at this operation, while moving the complete unit out of one room and into another takes 60 min. Two section mechanics take off belt while two face timbermen and a recovery man dismantle stands and rollers and move the tail piece. The miner operator trams the head piece out and helps with dismantling. In removing belt, one section is taken off the top followed by one section on the bottom. This leaves a clean path for the men removing the stands, which are stored against the ribs (pillars are not removed) ready for use when the time comes in the next place.

Trip Loading

THE MAJOR OBJECTIVE in setting up trip-loading facilities is prevention of delays to face units. A second is conducting such loading with no men if possible, and with no more than one if not possible.

Trip Movers

Various systems and units for moving trips past loading stations, whether they be ramps, elevators, belt discharges, or what have you, include the following among others now used:

1. **Gravity**—Possible but hazardous when the usual spragging practice is followed.
2. **Gravity Retarding**—Feasible with a rope and a brake drum with manually or motor-applied brake.
3. **Operator-Controlled Locomotive**—Fairly widely employed in the past and still employed in a number of mines. Ordinarily means an extra labor cost unless the same motorman pulls to sidetrack or outside in which case care must be taken to see that the trip-changing interval is not too great. Complete looping of track, discussed more fully later in this section, facilitates this trip-moving scheme. And where locomotives pull to the outside and heavy grades are encountered, a few operators put locomotives both in front and behind trips both with loop track and with conventional layouts.
4. **Remotely Controlled Locomotive**—Machine with brake set up as required, and with the controller on the first point, on separate section of wire which is energized to move locomotive and trip by switch operated by boomman or attendant.
5. **Remotely Controlled Trip-Spotting Hoist**—Sometimes accompanied by smaller hoist to pull rope back for coupling to fresh trip.
6. **Barney, Chain-Feeder and Ram-Type Between-the-Rails Spotters**—Newest in the line of trip-moving equipment, these units are positive and accurate in operation and permit designing transfer stations for maximum efficiency in trip changing. The changing function can be preset or controlled by limit switches for precision and also for automatic performance if desired. Also such equipment lends itself to operation by shuttle-car drivers, and thus, even if not made automatic, requires no special attendants.

Track Layouts

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an ad-

jacent heading. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

Sidetrack or loop-track systems provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack—if that is the system—may be in the same heading as the main track. More usually, however, it is in an adjacent heading, as indicated in the bridge-conveyor plan earlier in this section. Or the sidetrack may, in effect, be made continuous by tracking the second heading and installing chutes and crossovers at intervals, as indicated in the plan on p 30 of this issue. Double tracking represents some extra expense but does result in greater flexibility and more assurance of quickest-possible trip changes.

Full looping of track is becoming increasingly popular. In addition to the example herewith, another plan, using a hoist for trip spotting, appears on p 32. It will be noted in these plans that a reverse loop is made outside to put the cars right-end-to. One advantage, particularly where the locomotive haul is uninterrupted from room section to tipple, is that there is no need for separate sidetracks to store empties or loads.

Automatic Loading

Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining (*Coal Age*, August, 1953, p 99). Late-type underground stations (*Coal Age*, March, 1955, p 66; January, 1956, p 70) include facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

Switching Coal

The problem of switching coal flow from one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car (*Coal Age*, January, 1956, p 70) or articulated trip in which facilities to bridge the gap are built onto the cars. Thus, there is no need to stop either conveyor or elevator, or trip, during loading.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal while changing is in progress. When the new car is in position, the plate is tilted by the boomman and then is slid around on the top edge of the car to its next position. A new wrinkle in equipment of this type is a plate with holes at one end to accommodate hooks suspended from the top. As the car moves ahead, the hooks hold the plate and eventually tilt and dump it into the next car.

Heavier flows of coal, as off a mother belt, usually require power or some other type of equipment for a quick change. Power equipment includes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flop gate to divert the coal stream from one car to the next.

Main Haulage

WHATEVER ITS TYPE, the goals in main haulage are (1) ample capacity with operation scheduled to prevent any interruption of loading or mining at the face, and (2) operation with minimum manpower and equipment.

Rail Haulage

One-Stage or Multistage?—Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs. The possible savings warrant careful study of the question before the system is finally settled upon, or an existing relay system is continued.

Cars and Locomotives—Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal delivery.

In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings (*Coal Age*, September, 1952, p 76). Accompanied by reconstruction of the haulageway and the installation of big cars, the triple-header was delivering 4,500 tons over a 4½-mi haul with two men, compared to 4 and sometimes 5 locomotives and 8 to 10 men for 3,500 tons previously. More recently, a single 50-ton machine capable of pulling 1,600 tons on a straight, level track (*Coal Age*, January, 1954, p 111) has gone into service.

Aids to safety, efficient operation and low maintenance in car design include:

1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction-bearing wheels.** With high speeds and swivel trucks, as in 8-wheel designs, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion-resisting materials.** Newest is aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern electrical controls include provision for dynamic braking where grades warrant. For absolute reliability in such braking, a 32 v battery permits continued operation even when trolley power fails. Cabs with ample room and with bumper extensions high enough for complete protection of both motorman and triprider promote comfort and safety.

Track

Generally accepted standards for good main-line track include 70- to 90-lb rail on heavy treated ties laid in crushed slag, gravel or cinder ballast. The importance of treated ties is shown by one recent study indicating total tie costs for 1 mi of track for 20 yr as follows: treated ties, $10,600; untreated ties, $34,000.

Welding has come sharply to the fore as a means of

joining rails, with steel are the most widely employed. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth main-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switchthrowers and remotely actuated derails save labor and promote safety.

Double Track or Single?—Most authorities agree that double track is for the big mines, though they split on what is "big." Advantages of double tracking include complete separation and no interference between empty and loaded haulage. Also, since waiting at sidetracks and passing tracks is eliminated, fewer cars and locomotives are required. Furthermore, one track usually always is available and therefore production seldom if ever is completely interrupted. In addition, some mining men point out, double tracking where grades are heavy makes it unnecessary to use a tail locomotive, which might otherwise be considered desirable. Also, it permits installing spring-type derails on upgrades.

Almost the equivalent of double tracking can be attained by proper location of properly designed passing tracks, though where several locomotives normally pull to the bottom it might be desirable to double track that portion of the main line handling, say, 75% of the mine tonnage. An alternative is a marshalling yard at the point where all the tonnage, or most of it, comes together, with a single-track single-locomotive stretch to the portal, and single track with passing tracks inby the yard, perhaps supplemented by some double track. In view of these and other alternatives, careful study of the problem is essential to arrive at the correct answer.

Drainage—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate disposal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line. Incidentally, mine water may also be diverted for sprinkling at the face since it has to be handled anyhow and might as well be bled out of the main discharge system.

Grading—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

One problem is synchronizing grading and main-line extension with face advance to permit the latter to go ahead efficiently while at the same time providing enough open length so that a proper profile can be arrived at. In most instances, a stretch of 1,000 to 1,500 ft is necessary to fix the profile and thus determine where and how much grading must be done. Two suggestions for providing this distance are: (1) use a belt conveyor in advancing the entry, or (2) lay light track in a side heading to serve while advancing the headings and bringing up the heavy steel. If it is felt that the investment in a belt for this limited use is high, track is a lower-cost alternative, though not quite as convenient.

Track Cleaning—Smoother, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the intervals between cleaning. In many instances, a considerable tonnage of good coal is reclaimed in the cleaning process, which might well be credited against cleaning cost. Some mines, as a matter of fact, figure they are well ahead of the game by salvaging coal off the track.

Haulage Control

Except where the haulage system is of the simplest type, the dispatcher is essential not only for efficiency in haulage but also as a means of keeping a finger on conditions and progress throughout the operation for the benefit of the foreman and superintendent. In his business, he uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine.

Ready communication with locomotive operators is the great advantage of the carrier-current instrument, the use of which some mine managers have stated has raised output and efficiency 10% or more. For better coverage of key points at a practicable cost, at least one mine (*Coal Age*, December, 1954, p 67) has supplemented carrier-current equipment with "loudspeaking telephones." These are tied in with the carrier-current system, including the locomotives, and are provided with auxiliary battery power to permit communication if the power goes off. As an example of how the units extend communication range, it is now easy for the boomman at the belt discharge, for example, to talk to the shuttle-car operators feeding to the belt, as well as to the locomotive operators and outside stations.

Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program, making it, in the experience of many mines, more accurate and efficient.

Belt Haulage

Because of the increased difficulty and cost of setting up and maintaining an efficient track haulage system in thin coal where top or bottom must be taken, the belt conveyor, with a few exceptions, first made its mark in underground transportation in low-vein operations. It was of particular benefit in eliminating brushing and providing continuity of transportation in panel haulage, which normally aggregates several times main-line haulage over the life of the property, and was a natural complement of conveyor transportation in rooms. Since that time, the belt also has moved into thick-coal mines for both main-line and panel service.

The reasons for one belt installation in thick coal, where the output will aggregate 1,000 tph, include the following:

1. Less manpower in building up and maintaining rated tonnage.
2. Less routine deadwork (brushing, grading, timbering, etc.) in establishing and maintaining haulage.
3. Fewer haulage delays, with consequent increase in face productivity.

4. Fewer haulage accidents.

5. Greater concentration of production with greater overall efficiency.

In this installation, a separate rail system for handling men and supplies was installed, with the result, according to operating management, that men and supplies are handled more efficiently while at the same time there is no possibility of interfering with coal haulage.

One secret of efficiency in main-line belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturer. Another is the employment of one man properly trained and equipped to patrol service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible, put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the main-line units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

Fire Protection—Measures to prevent ignition and retard fire propagation include the following:

1. Use of neoprene, which also improves troughing and lengthens life.

2. Preventing or protecting against drive-pulley slippage, including automatic counterweighted takeup and devices to stop the motor when the belt slows down or stalls for any reason.

3. Preventing stuck idlers by proper lubrication and service, supplemented by good housekeeping to eliminate material that might be ignited.

4. Following proper inspection and maintenance methods to eliminate rubbing of belt against the frame.

5. Removing electric cables and other possible sources of ignition to parallel openings.

Electrical Protection—Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.

2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.

3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.

4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the skate-wheel spring contact-maker described on p 55 of this section.

5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact-type so that the inby conveyor will start again when the overload is cleared.

6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pull-cord type controls fastened to the roof also provide protection against falls.

7. Providing a drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley, are two possible devices. A third is a differential control with two pulleys, one riding the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

Belt Cleaning—A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. A recent one apparently coming closest to the ideal is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89).

Detecting Belt Tears—One of the few practicable methods of detecting major tears in operating belts has been developed at a middle western mine (*Coal Age*, January, 1956, p 88). It consists of a horizontal rod 2 in in front of the head pulley. When struck by a torn flap thrown out from the belt by centrifugal force, the road is knocked down to open an electrical switch and stop the belt until it receives attention.

Hoisting

IN THE ABSENCE of special circumstances, the belt slope is the usual coal-hoisting facility installed today. Low operating labor and low maintenance are the major reasons, while improvements in belt design, including rayon, nylon and steel-cord tension elements, have made it possible to install single belt runs up to 3,000 ft or more in hoisting, thus raising the vertical lift to more than 800 ft.

The British-developed cable belt is a possible new contender in hoisting service, with one installation over 3,000 ft long in service in Canada. In the ordinary belt, much of the carcass weight and thickness represents strength in tension to permit the load to be moved without pulling the belt apart. In the cable belt, the pulling is done by wire ropes, one on each side and independent of the belt. Shoes incorporated in the belt, or more recently a grooved edge molded onto the belt, rest on the ropes and provide enough friction for pulling the belt and the load along.

Belts also work equally well in lowering coal where the terrain permits their installation at inclinations of under approximately 20 deg. Other facilities for lowering include monitors and rope-and-button conveyors.

Any of the standard types of dumps may be employed in transferring coal from mine cars to the belt, unless bottom-dump cars are employed. If so a necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts (see "The Preparation Guidebook" for example) are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speedup belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

The tendency is to make hoppers and bins feeding slope belts of a size to hold at least 15 to 30 min of production. Unless, as frequently is the case with drop-bottom cars, the trip is pulled through the dump by the locomotive, power trip feeders and trip makers should be employed for efficient car handling. Properly placed and operated sprays keep dust within reasonable limits. An alternative is a hood and duct system with collectors either above- or below-ground. In some instances, trip feeding, dumping and trip making are completely automatic by virtue of the necessary starting, stopping and limiting switches.

Belts may be and are used in hoisting between levels, or from the face to the surface where seam pitch is not over 18 to 20 deg. Above that, some form of rope hoist is required. It usually is a single straight drum powered by an AC motor. Lowering is made more efficient and smoother by installing DC dynamic braking.

Shaft Hoisting

The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduces dead weight and consequently improves the hoisting operation. Where platform-type cages are employed, the British have developed the "container" idea to speed up hoisting and materially reduce labor. In this system, the coal is dumped into hoppers from which it is chuted alternately into two containers with bottom doors on which regular flanged wheels are mounted. As a container is filled a ram shoves it onto the cage, moving the empty container off for refilling. At the top, the process is reversed, and the container is dumped automatically by permitting the bottom door to swing down.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist—skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging. Even if complete automatic operation is not desired, automatic cagers, trip-makers and the like speed up the hoisting process and save labor.

Handling Men

IN THESE PIPING portal-to-portal days, a major consideration in designing facilities for handling men is keeping travel time to a minimum. As an example, if actual working time is 6¼ hr, or 375 min, increasing it 15 min is equivalent to producing the same tonnage with 1/25th fewer men. Greater time savings enhance the benefits and increase the limit of expenditures to secure them. At an average of 6 mph for a man trip, if permitted by law or regulations, cutting the distance 2 mi saves 40 min per man in production time.

Portal relocation, among other things, provides an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field supply setup, with possibly also a field maintenance shop that is much nearer the active workings. Aside from supplies and maintenance, key objectives in portal design include:

Ample all-weather parking.

Good wash and change facilities.

Good lamphandling facilities.

Offices and meeting places for supervisors.

Protected facilities for men waiting to board trips—from weather and electricity particularly.

Adequate first-aid facilities.

The plan shown in the accompanying illustration also includes a laundry for towels, which are furnished in this instance at a small fee to men who desire this service.

Hoisting

Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men, which reduces the total time required to put a crew into the mine car or bring it out. The cage may also be adapted to handling heavy supply items, though the tendency is to use the regular opening for this purpose, especially if it is a drift or slope.

Drilled shafts with automatic hoists may provide a lower-cost answer to the problem of putting portals close to the working areas. At one mine (*Coal Age*, November, 1955, p 60) a 72-in drilled shaft was fitted with a double-deck circular cage with a capacity of 10 men per deck. Pushbuttons control the automatic hoist. Hoisting distance is 487 ft. Travel time was cut 45 min with a resultant rise in output.

Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a pushbutton under the control of a foreman or triprider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "Ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating the stairs in the "up" direction.

Car Transportation

Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service. Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, and with battery power, is available.

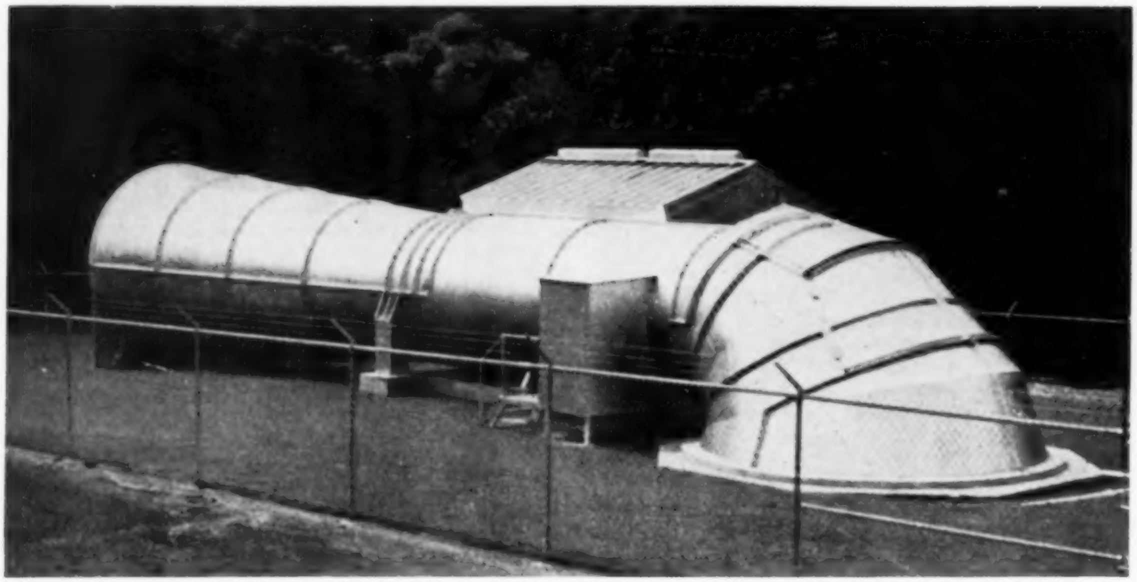
Low coal makes it more difficult to cover cars that go into areas where top is not taken. Flat-bed rail cars with rubber mats can be used, with the men lying crossways. Self-propelled types include one in which the men lie down with knees up in each end (*Coal Age*, March, 1954, p 190). Capacity is sufficient for a section crew of 11 men. Height over the rails is 24 in. As in thick coal, equivalent equipment is available on rubber for thin-coal operations.

In addition to regular mantrip cars, a variety of rail and rubber-mounted cars may be employed to save time and promote efficiency in transporting mechanics, electricians and repairmen, as well as officials. The list includes even small one-man three-wheeled "trikes" for trackless operations. Types for mechanics, electricians and repairmen include tool and supply boxes and wells or decks for carrying heavy items.

Belt Transportation

Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be re-started without a check to see that no hazard is involved. A space of at least 6 ft must be maintained between each man on a belt.

Belts may be reversed to take men in, and a few mines have designed mainline systems with that in view. In going in, men necessarily must get off and change if more than one belt is in service. There also should be a rigid rule that men get off and change coming out as well. Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.



MODERN EQUIPMENT in use with airshafts that now can be sunk by more economical methods is a keystone in the arch of good ventilation. Supports include clean airways, tight stoppings and effective controls.

Ventilation

TRADITION has it that it is top management's responsibility to provide the required quantity of air at the main intake, from where it becomes the responsibility of mine management to conduct it past the active faces in a safe and proper manner. Everyone in the mine is vitally concerned in maintaining the system at highest-possible efficiency for safety and low cost.

But everybody's business has a way of becoming nobody's job, causing efficiency to wither. A modern mine should enjoy the services of a competent ventilation engineer in the same urgency as those of an electrical, mechanical or mining engineer.

Having set up these conditions of responsibility and authority, management has created a favorable atmosphere in which ventilation can be made most efficient and can be most easily maintained at that peak of efficiency.

Taking it up at that point, experts in the art agree that any effort to improve, modify or update a coal-mine ventilating system must be based upon accurate pressure and velocity surveys of the mine in question. Regions of high resistance or excessive velocity must be identified, and the extent of wasteful leakage must be determined. Having this information to guide him, the ventilating engineer may then select the places where his investments in time and money will be most rewarded.

Basic Principles

MOST OF THIS EFFORT is put forth with one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill, it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because (1) power varies as the cube of the velocity; (2) pressure varies as the square of the velocity, and (3) quantity varies directly with velocity.

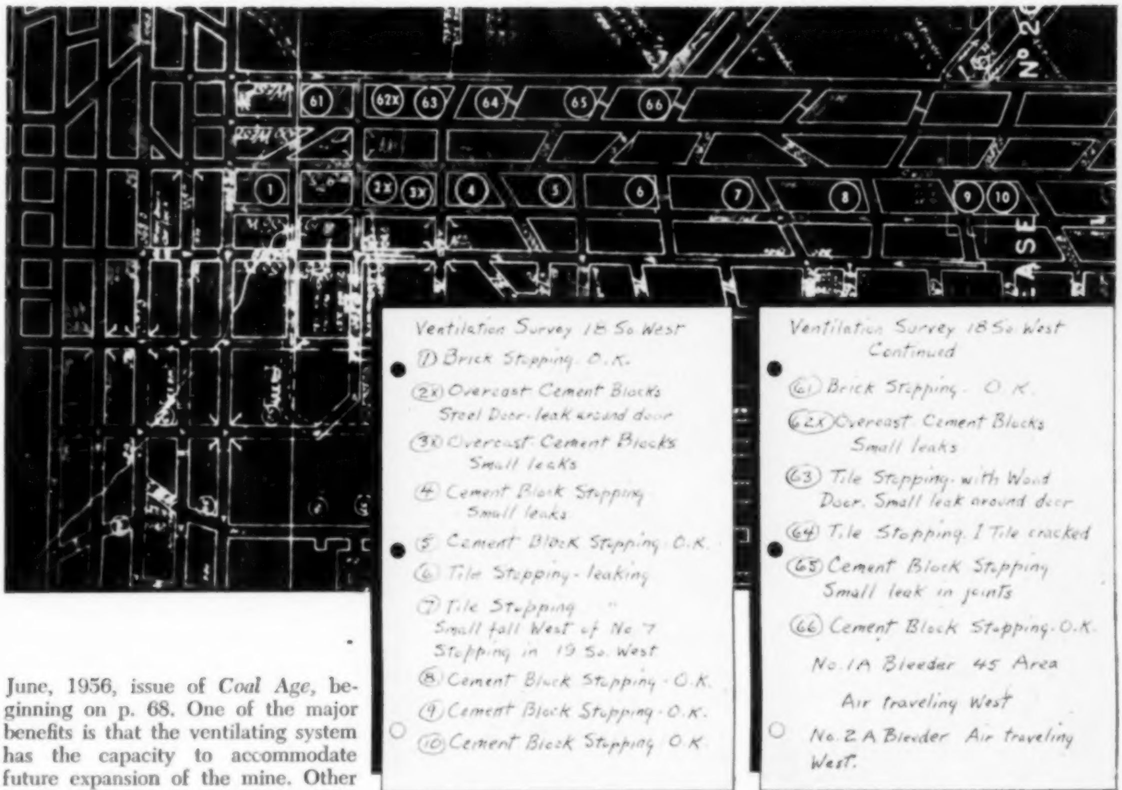
A change in any of these conditions naturally forces a change in all others since all are interdependent. Furthermore, existing conditions at a particular mine, lumped together in the term equivalent orifice, finally determine the magnitude of the ventilating job.

But it is possible to change or control the conditions which determine the ventilating job. For example, doubling the number of airways to carry the same quantity reduces the velocity by half and the total power required by three fourths. Similar improvements in varying degree may be achieved by cleaning up airways to reduce resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining. Thus it may be possible to ventilate at reduced velocity or with less volume.

In making the surveys upon which these approaches to better ventilation are based, the ventilating engineer may employ sensitive altimeters or inclined manometers in determining the pressure gradient of the mine.

A full account of how one company conducts these surveys and the benefits that accrue is contained in the



FIRST STEP in improving ventilation is a complete survey of the system designed to pinpoint weaknesses.

June, 1956, issue of *Coal Age*, beginning on p. 68. One of the major benefits is that the ventilating system has the capacity to accommodate future expansion of the mine. Other savings include: (1) elimination of the need for a 400-ft airshaft, (2) elimination of a need for additional airways and (3) possibility of ventilating increased area without speeding up the fan.

Such savings result from performing the cleanup and improvement indicated as necessary by the survey.

Ventilating Equipment

TODAY'S MINE FANS are as efficient as the propellers of a sleek airliner, including even a modified "feathering" feature which permits changes in blade pitch as dictated by changing conditions. That makes it possible to select a fan that will continue to provide adequate ventilation at high efficiency as underground workings expand.

Dependability in fan service can be assured through the use of auxiliary drives—a diesel engine, for example—in standby service. A recent refinement in control for outlying fans employs carrier-current equipment (see *Coal Age*, October, 1955, p. 68) for both signalling and control.

Better design in ventilating materials is not confined to fans alone. Also available are improved curtain materials, including treated cloth and neoprene-coated types. Spad drivers have been developed to reduce materially the time required to install line curtains and checks.

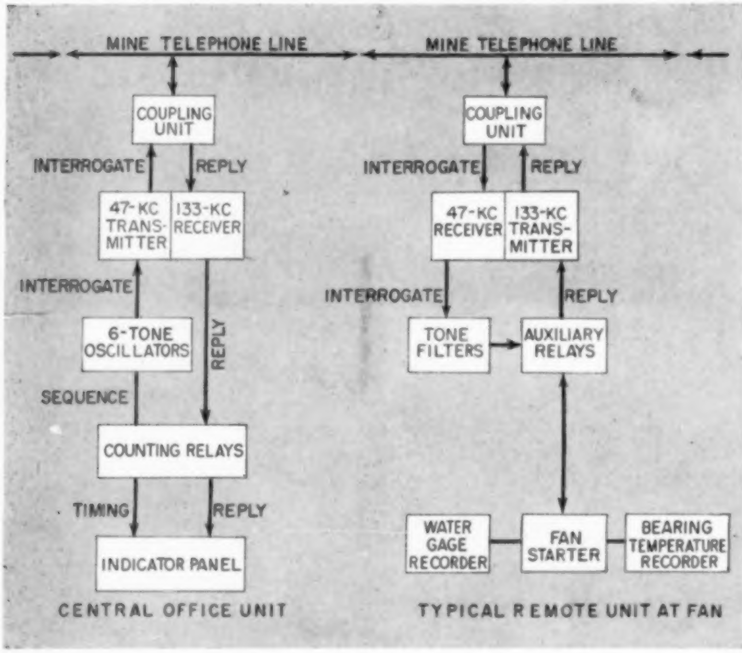
New materials for stoppings include telescoping metal sections, sheet plywood and plastic sheeting, as well as inflatable stoppings. Big features in both of these are rapid installation for savings in labor and full reclamation for savings in supply costs. Other materials include concrete blocks, also reusable in many instances, and sprayable coatings for sealing against leakage.

Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful air-current controls. As a result of these developments, overcast is no longer a bad word in designing ventilation systems. They are used more and more in modern mines as the best means of dumping used air into the returns with least ado or of initiating splits.

Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of some help when properly used with the approval of regulatory agencies. Better ventilation in continuous-mining has been achieved through the use of auxiliary exhaust fans and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment. Improvement of these fans is a matter now receiving intensive study in the industry.

In anthracite, trumpet-shaped air movers, connected to compressed-air lines, have been used to direct air to the faces of steeply-pitching places beyond the last open cross-heading.

Doors are a necessity at some point in every system. Recent developments in these include a new compressed-air-powered automatic door for heavily-traveled haulageways. The operating controls are actuated through the trolley system and all mechanical linkage and the operating cylinder are suspended from the mine roof and attached to the top of the door. None of the parts are exposed to wet bottom



CARRIER CURRENT now is used in a setup like this to control and protect an outlying fan. Fan outages are indicated in central office.

conditions nor to damage from possible derailments. Some mines now swing their conventional doors from steel jacks to make possible faster relocations.

Lower Power Costs

THE ADVANTAGES to be found in this modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air.

The penalties in fugitive air, measured in terms of wasted power, border on the tragic. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube, while the increased velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. Another and better way is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Airshafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, the cost of sinking a shaft is not what it used to be. In one instance (*Coal Age*, April 1955, p 74), a shaft was sunk by drilling a circle of large-diameter holes with an overburden drill, then shooting the hard core against the relief provided by the drillholes. The job was quickly done with fewer men and in greater safety.

In another instance (*Coal Age*, November 1955, p 60), a shaft was sunk using a new type core drill which cuts a 75-in hole at rates of 4 ft per hr in limestone and 1 ft per hr in sandstone. And an article in the July 1956 issue of *Coal Age* (p 72) describes the use of a crawler-mounted loader in a recent shaft-sinking operation.

One-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Assuming that a certain 100-hp mine fan moves 100,000 cfm to produce an effective quantity of 60,000 cfm at the face, only 35 hp would be required to move 60,000 cfm past the face if the 40,000 cfm leakage could be eliminated. In an area where energy sells for only 1c per kwh the power saving, figured in pure theory, would amount to about $4,237 per yr for continuous service. Preventing leakage and promoting one-way travel are real money-makers.

Splitting and Regulating

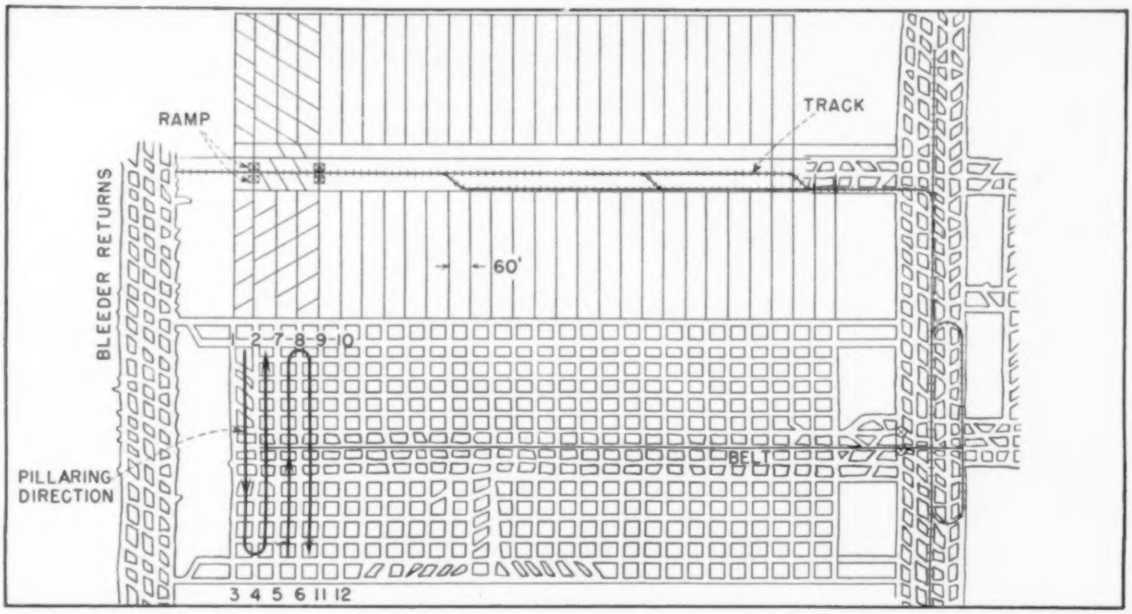
INCREASED SAFETY is by all odds the big reason for splitting air currents underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is conserved, and better local control of the air becomes possible. Best practice in splitting requires that the splits be separated near the point of intake of the main current and rejoined near the point of final discharge from the mine to fully realize this improved control.

The ideal situation, which shows all splits naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all other



BLEEDER OPENINGS around areas recovered by continuous mining keep gob free of methane, increasing safety as mining becomes more concentrated. Such openings should be considered in planning a change to continuous mining.

splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roof-bolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.

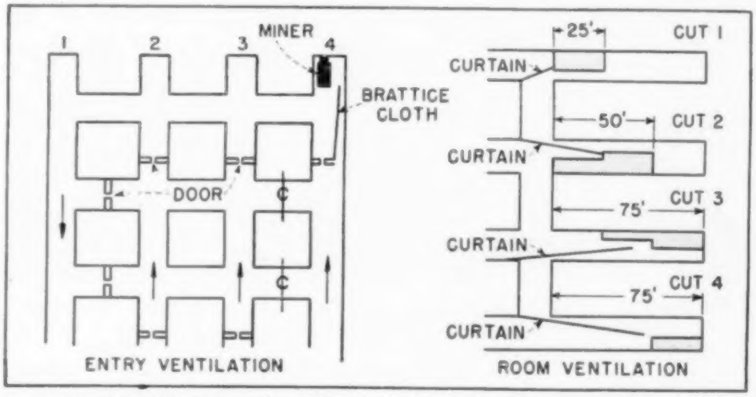
Bleeder Headings

ACCUMULATIONS OF GAS in worked-out areasare especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through the gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration through seals or otherwise during periods of low atmospheric pressure.

Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Specialized designs for ventilation may become necessary when a change to continuous mining is in the works; particularly if methane is a problem. At one mine (*Coal Age*, February 1956, p 88), the problem was handled by designing a bleeder-entry system to serve pillar areas and by setting up effective line-curtain techniques for use at active faces, as shown in two of the accompanying illustrations.



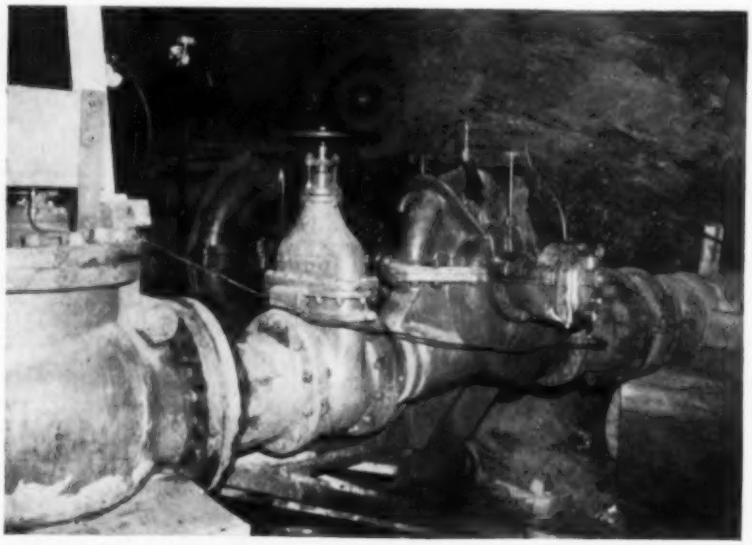
MAXIMUM QUANTITY at the right velocity for dust and gas removal are provided by using doors and curtains like this in one continuous-mining plan.

TELESCOPING SUPPORTS for line curtains are designed for bolted workings.

Pumping and Drainage

THE BEST WAY to insure near-neutral effluent from a coal-mining property is to keep the water from running through the mine. This also happens to be the cheapest, surest way to handle the problem of mine drainage . . . two birds with one stone. Thus, clean-streams requirements may turn out to be a blessing in disguise.

Diversion ditches around openings, sealed stream beds at troublesome points, grouting underground to seal off stream channels, new channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. New flume materials, including even kraft paper impregnated with resins, now make it possible to conduct surface water across pervious areas of mining properties and dump it back into natural drainage channels on the other side. In round numbers, it comes down to this: For each 35 gpm diverted around a 100-ft-deep mine, a horsepower's worth of pumping capacity can be eliminated.



PROVIDING A GOOD PUMP is only one step in the process. You also need a piping system planned for long life and minimum maintenance

DIVERT SURFACE WATER—You might try impregnated paper (left) or wood flume, lined or not, as needed, to keep water out of the workings.

Gravity Drainage

BUT IT IS neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow. Again it becomes a matter of seeking the cheapest way out of the situation, and that means taking fullest possible advantage of gravity flow, either to the outside or to a well-planned sump.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage. Siphons may be employed in transporting the water over local rolls, thus continuing power-less water handling.

In other instances, it may be possible to drill boreholes to the cropline or into a sump area to permit gravity flow by the most direct path. At one mine, where some places necessarily are advanced to the dip, 2-in boreholes are drilled at the face through 60 ft of bottom rock to old workings in the seam below. The old workings are open to the outcrop, facilitating gravity drainage of both seams. This, too, is a possibility not to be overlooked.

When all's said and done, however, chances are some pumping will have to be done. But handling water with today's equipment is a far cry from the difficult job it was in the past. Today's advantages include efficient pumps for any type of duty, electric power in place of steam, automatic controls to

cut the cost of operation and materials designed for long life at reasonable cost.

The basis of good drainage is a well-engineered plan, of course, first making full use of surface-water diversion and gravity-flow channels, then turning to pumping installations.

Pump Selection

THE TYPE OF PUMP selected depends entirely upon the pumping job to be done. In two out of three of today's mine-drainage applications, centrifugals of one type or another will be found, but each of these is practically a tailor-made unit. The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. The best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for the application.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much water is to be handled, how much variation may be expected in suction and discharge heads and so on. Corrosion- or abrasion-resistance may be the determining factor, and the manufacturer will have to know this before he can recommend a pump. Numerous special-purpose units are available, including even a pump operated by a belt driven by a conveyor-belt idler.

For example, if the water is free of solids, a multistage centrifugal unit to work against a high head may be used, but if solids are present a number of single-stage units in series should be used because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors. Complete foreknowledge of the conditions under which the pump is to work is vital to successful selection.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations because of the resulting flexibility.

Planning Water Lines

THE BEST PUMP in the world can be limited by a poorly-designed piping system. What are some of the factors to be considered in system design?

Usually the major variable which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter straightest pipeline it is possible to achieve. Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

A standard 90-deg elbow for 6-in pipe is equivalent in friction tendencies to 16 ft of straight pipe, for example, and an open globe valve in the same line is equivalent to 160 ft of straight pipe. The reason for using a minimum of fittings is obvious. Tables showing straight-pipe friction equivalents of various fittings are found in a number of handbooks and should be used in pipeline layout.

In the normal case, pipe of the largest usable diameter will be most economical in the long run. With the length of the piping system and the number of fittings known, it will usually work out that the combined costs of piping, pump and power will be lower with large pipe.

A well-designed pump installation will show these features:

• The suction line leads straight into the pump for a length equal to four to six pipe diameters.

• The suction pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an eccentric reducer which is properly placed to eliminate suction-line air pockets.

• The drive motor and pump are in good alignment.

• The piping is supported so that the pump carries none of the pipeline weight.

• Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Drainage Systems

FITTING THE PUMPING SYSTEM into the overall mining plan is another matter. This is another instance where each setup is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of draingage cost is shown in an accompanying illustration, where three gravity-fed sumps and three pumping stations remove 3,000 gpm in three stages over a distance of 3½ mi. Each station is provided with independent pumping power through a borehole cable.

Four Steps to Better Drainage

I. Keep water out of the mine:

1. Use ditches, dams and flumes around surface breaks.
2. Seal leaky stream beds with culvert pipe.
3. Grout broken strata where conditions permit.

II. Employ gravity if you can't keep water out:

1. Where underground ditches or siphons can be used, they consume no power.
2. Direct gravity flow to high-capacity sumps to concentrate pumping loads.
3. Open gravity drains to the outcrop, if possible.

III. Planned pumping costs less, is trouble-free:

1. Choose modern pumps with automatic controls to reduce attendance and maintenance costs.
2. Construct main sumps at locations where a minimum of gather-pumping will be required.
3. Use boreholes wherever possible to achieve a straightline flow and minimum pumping distance.

IV. Control drainage costs with proper materials:

1. Select alloys that suit your water conditions.
2. Use large pipe for high capacity at minimum power.
3. Install lightweight pipe and fast couplings to reduce labor costs.

HIGH HEADS AND LARGE VOLUMES in water lines call for stout anchorage like these floor and rib bolts to keep lines from kicking out.

MODERN SUPPLIES can reduce service labor. Fast couplings and plastic pipe are designed for this purpose.

PUMP AND BOREHOLE COMBINATIONS are newer drainage cost-cutters.

Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles thus making a peakless pumping load on the power system. The sumps act as accumulators in making this duty possible. If level power demand is important, either to head off penalties in the power bill or to prevent overloads on conversion substations, this method could be used.

At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehole to the surface. The solution, as shown in an illustration, was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.

It was found in this job that it was possible to locate the pump at an elevation where a positive head on the suction lines could be used to balance a portion of the discharge head against which the pump had to work, thus saving power. And it was found also that the most difficult part of the job was restraining the 18-in discharge line with the pump operating at full head. The solution to this required the installation of steel bands bolted to floor and rib around the pipe on each side of each joint.

The pump and its drive motor were mounted on mine-car wheels to make it easier to replace either unit in the event outages occurred.

At another anthracite property, it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible. The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-v AC motor.

Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects. When jobs of such magnitude must be done, it pays to get the best services available.

The possibility of using boreholes and vertical-turbine pumps in combination should not be overlooked.

New drills, for sinking the boreholes faster and cheaper, make this system worth notice.

Cutting Drainage Costs

SO FAR, the drainage plan has been built up to take full advantage of the economies in surface-water diversion, gravity handling wherever possible and proper pump selection and application. There is one more requirement to be satisfied. That is, the system must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time. Drainage costs can be kept under control only to the extent that these goals are met.

Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

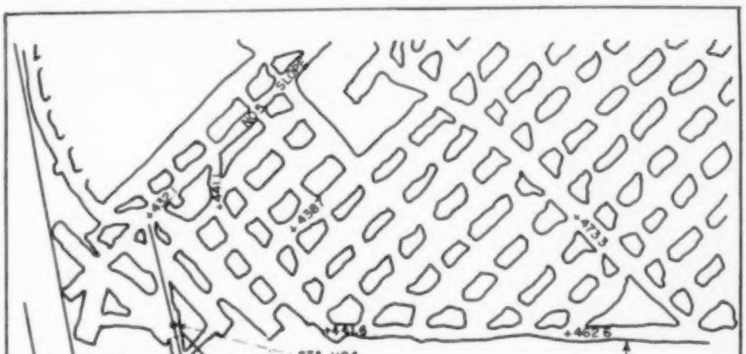
Saving Labor in Pumping—Pump controls ranging from simple float switches to elaborate fully-automatic systems for large stations are available. Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters. Developments like these help keep the cost of maintenance labor at a rock-bottom figure.

Longer Pipe Life—Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased the time-in-service for underground pipelines. The happy result is that since fewer pipe changes are necessary, the drainage system can be maintained with fewer men.

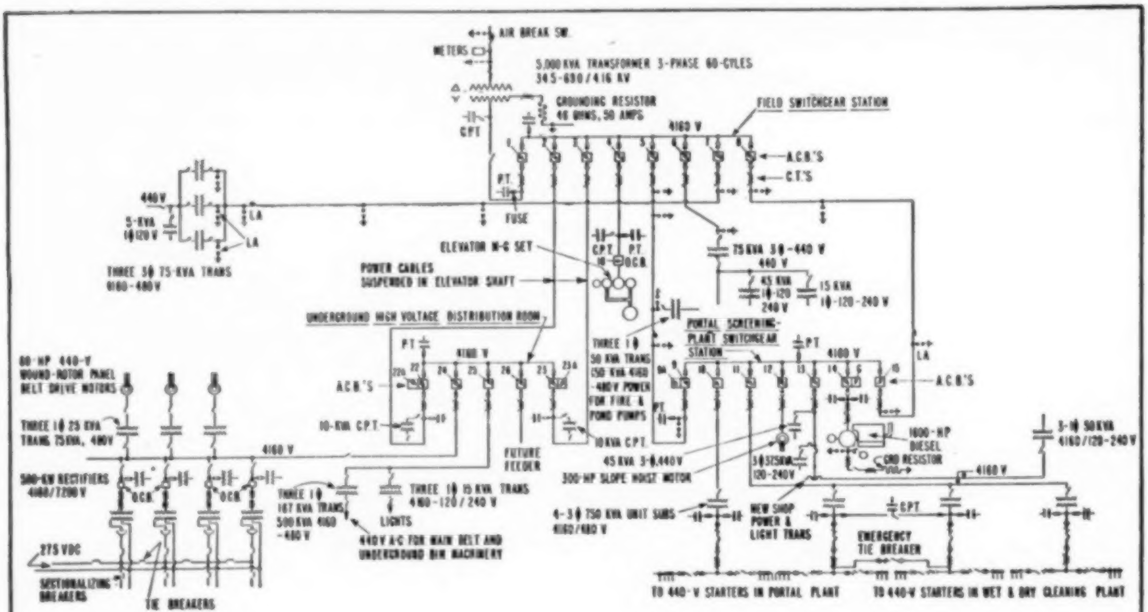
Faster Relocation—Fast snap-action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings. And the latest is a new tool that rolls a groove into thin-walled lightweight pipe to permit use of fast couplings.

Quick Installation of Longer Runs—Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.

LIGHTWEIGHT PIPE and speed couplings save time and labor in drainage. Aluminum or plastic also defeats corrosion.



HORIZONTAL BOREHOLES, another drainage possibility, permit flooded workings to be unwatered through lines in active mine.



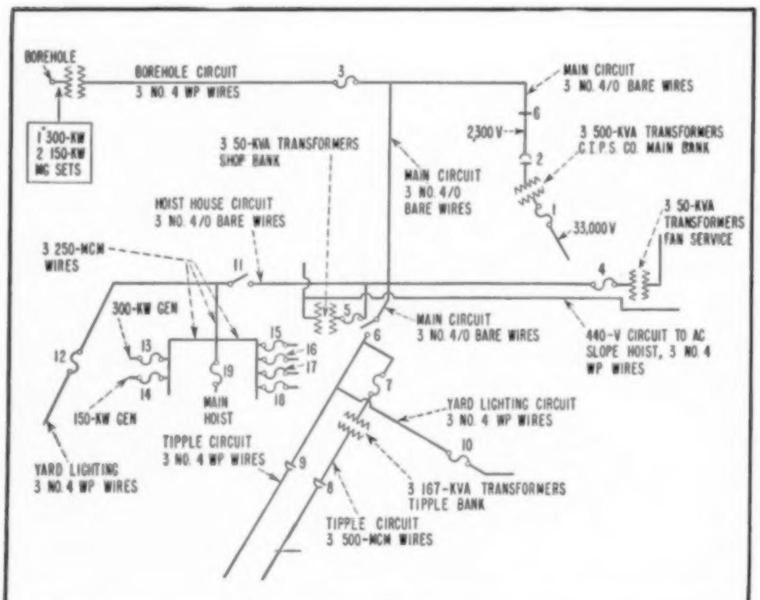
CIRCUIT-BREAKER ASSIGNMENTS (4,160 v):

1 Incoming line
2 Underground feeder to CB 22
3 Underground feeder to CB 23
4 Man-hoist elevator
5 Transmission line to prep. plants
6 Washhouse area light and power
7 Transmission line to upcast shaft
8 Bus feed from emergency supply
9A Remote control for field sw. station
9 Incoming line from field sw. station
10 Feeder to 750-kva subst. at portal plant
11 Feeder to three subst. in cleaning plant
12 Material slope hoist
13 Lights for cleaning plant and shop
14 Slope-belt motor (1,500 hp)
14G Slope-belt motor as AC generator
15 Emergency power to field sw. sta.
16 Starter for elevator m-g set
22A Compartment for control power transf.
22 Shaft-cable feeder from CB 2
23A Compartment for control power transf.
23 Shaft-cable feeder from CB 3
24 Feeder to 500-kw rectifiers
25 Feeder to 500-kva transf. sta.
26 Future mine feeder

LEGEND:

OCB—Oil circuit breaker
ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
CPT—Current-potential transf.

MODERN AC SYSTEM provides adequate steady power for continuous mining, maximum safety for the men in the mine, and full protection for mechanical and electrical equipment.



PROTECTIVE EQUIPMENT IN AC SYSTEM for new mine is shown by numbers: (1) primary fused cutouts; (2) secondary breaker; (3) 100-amp fused cutout with 80-amp links; (4) 50-amp fused cutout, 30-amp links, fan circuit; (5) 50-amp fused cutout, 50-amp links, shop transformers; (6) pole-top switch, 3-pole gang-operated, 7.5-kv, 400-amp, tipple circuits; (7) 200-amp 7.5-kv trip-out fused cutout, 125-amp links, tipple transformer bank; (8) 600-amp OCB, tipple circuits; (9) 400-amp OCB, tipple circuit; 50-amp fused cutout, 2-amp links, yard lights; (10) disconnect switch, 7.5-kv, 400-amp, hoist-house circuit; (11) 50-amp fused cutouts, 2-amp links, yard lights; (12-13) 200-amp fused cutouts, 5,000-v 200-amp links, 300-kw m-g set; (14) 200-amp fused cutouts, 5,000-v 150-amp fuse links, 150-kw m-g set; (15-18) 50-amp fused cutouts, 50-amp links, compressors; (19) 200-amp fused cutout, 5,000-v 200-amp fused links, main hoist.

Electric Power

THE FINAL TEST of an underground electrical supply system—or any electrical supply system, for that matter—is whether it will deliver rated voltage to the motor terminals at normal running loads. As a matter of fact, if it can deliver higher than rated voltage, within limits imposed by motor design—usually not over 10% over or under rating—so much the better. At heavy loads, a slight overvoltage might mean the difference between a lot of cable trouble and no more than normal. With AC, of course, a good power factor also is necessary for the best in service.

An essential item in good electrical service, therefore, is a record of voltage. Regular checks should be made with portable meters, and under some circumstances recording-type meters may more than pay their way.

Primary Power

WHETHER TO DISTRIBUTE in one or two steps is one question that can arise in setting up or revising primary electrical power facilities. Normally, the one-step system is the one employed, with either 2,300 or 4,160 v as the nominal transmission pressure. The trend is toward 4,160. And as concentration, loads and transmission distances, particularly for cables, increase, 6,000 v may be expected to come into the picture with possibly 13,000 at some future date.

Two-step systems are relatively few in coal mining, and where they have been adopted the "super-primary" voltage usually is 13,000.

Three-phase transformers are growing in popularity, though the old-reliable single-phase units are still in the majority. But whether three-phase or three single-phase stations are employed, protection should include lightning arresters, circuit breakers, ground-protective equipment and other control and protective facilities. The two accompanying diagrams show the facilities at two new mines, including control and protective equipment, as well as how the circuits are set up to serve surface facilities in addition to underground. One plan, it will be noted, includes a 1,600-hp diesel emergency generator.

Central Metering—Though the rule is not completely hard-and-fast, it usually is worth a fair investment in extra lines to permit metering of all incoming power at one point.

Power Factor—Without correction power factor at the average coal mine would be 60 to 85%—sometimes less but seldom more. Corrective methods and equipment include:

Synchronous motors, 0.8 leading, on m-g sets.

Synchronous motors for equipment, such as pumps, fans and the like, requiring, say motors of 100 hp or more.

Capacitors to supplement other forms of correction and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area. Even if power-factor penalties are not included in the rate structure, improvement is warranted to reduce the wattless current in wire, cable and motors. Theoretically, correction should be installed with each induction motor of any size, but a more-practicable system is capacity for a group of motors near the center of such a group. The farthest-back location, and the least preferable as a rule, is the substation.

Distribution

Choices in distribution of 2,300 or 4,160 v AC include overhead pole lines to surface substations and facilities, normally bare wire but occasionally weatherproof cable; underground cable systems; and a combination of pole lines and cables. Where openings may be made along outcrops or the cover is not too deep for boreholes, the pole line normally is preferred. Man-and-materials or air shafts back from the main portal are other spots where pole lines may be terminated. If the rule of not over 3,000 to 3,250 ft for transmission of 250-v DC or 440-v AC is observed, and unless a system can be worked out so that the opening can serve 3,000 to 3,250 ft outby as well as inby, new openings and terminals for the pole lines theoretically would have to be established every 0.6 mi. An alternative is a certain amount of underground cable to supplement the pole lines.

Putting the primary distribution system on the surface, other things being equal, provides a better opportunity for developing a system providing for feeding most key points from two directions. Even if extra line is necessary, the insurance against interruptions may more than overbalance the cost. Laying out an underground cable system to feed from two directions may be more difficult or impracticable, but a check on feasibility should be made in any event.

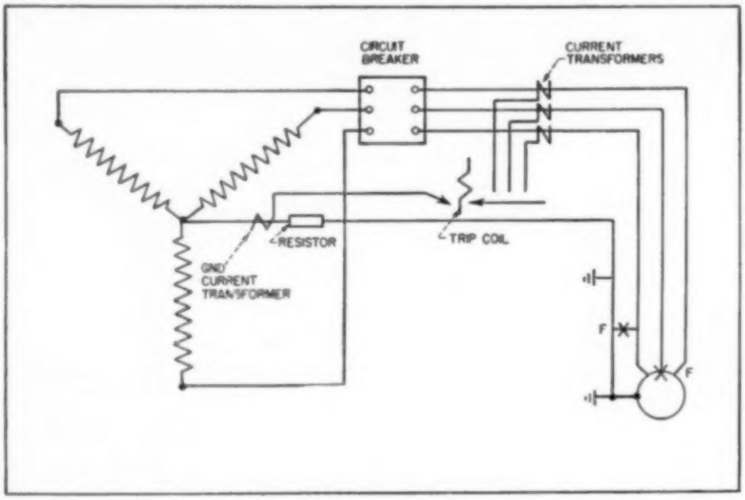
TYPE SHD cable, rated at up to 15,000 v, is becoming the most popular type for underground service. Each insulated conductor is covered with copper shielding braid to equalize surface stresses and eliminate static discharge—the cause of corona cutting. Grounding conductors, one for each power conductor, are placed in the interstices. A neoprene jacket over all completes the assembly.

Borehole and Shaft Installation—Neoprene-jacketed cable may be used in taking AC down boreholes or shafts, provided, among other things, depth is not too great. Deep shafts or boreholes usually warrant armored cable, which can be supported by the armor wires with no strain on the conductors and, in shafts, is protected against falling material or moving equipment.

With neoprene-jacketed types, the entire cable, if it is short, may be hung from a clamp or basket-weave grip at the top. Longer cables may be clamped to a messenger wire in boreholes. A more frequently used type of suspension is supporting the entire weight of the cable by clamping each conductor to a separate strain insulator.

Preferred procedure in installing cables in boreholes is to pull the cable up through the hole with a wire rope and hoist, truck or bulldozer. Where it is necessary to lower the cable, the reel must be provided with adequate braking facilities. A bulldozer or some other heavy piece of equipment may be employed to control lowering of the entire cable or the final end into the hole. For example of bulldozer use, see *Coal Age*, May, 1954, p 116.

Looping may be used to lower cables into shafts. One end is permanently anchored and the other is lowered by a wire rope. The cable loop in the shaft should be at



AC CIRCUIT PROTECTION by grounding transformer circuit to neutral of Y-connected transformer secondary.

least as large as the diameter of the cable reel. Items required in this lowering method include a large sheave at the shaft, a pulley system along the ground for controlling lowering, a truck to pull the cable into the shaft, and a bulldozer for retarding when enough cable is in the shaft to pull the remaining section in.

Underground Installation—Where adequate protection and grounding are available, neoprene-jacketed cable may be installed in accordance with the same standards as armored cable. In other words, it may be supported on messenger wires or directly on hangars, both suspended by insulators, or it may be buried. The location may be either the intake airway or the haulage opening, provided, particularly in the latter instance, that proper protection against moving equipment and other hazards is provided.

A new trend in aerial installation is the supported cable along the rib or roof. In one version, the conventional power cable is tied to a high-tensile messenger cable by metal binding straps. Or, three single-conductor cables may be tied to the messenger. Easier connecting and tapping are single-conductor advantages.

Protection

Major items involved in the protection of AC distribution systems, particularly of the cable type, include the following:

Approved-type lightning arresters at the point where the circuit enters the mine, as well as back at the substation if the entrance is some distance from the substation.

Outside switching facilities comprising either a disconnecting switch or a circuit breaker, preferably the latter. The breaker should trip on both phase overcurrent and ground-fault current.

Disconnecting equipment at the bottoms of boreholes, if entrance is by this means, preferably subway-type oil cutouts or oil switches.

Suitable disconnect switches at each branch circuit. These may be the same as equipment used at borehole entrances. In more-comprehensive systems, where automatic sectionalization may be desirable, circuit breakers with suitable relaying equipment may offer advantages.

Suitable junction boxes and couplers. Plug-in-type couplers should be interlocked so that the key for opening one can be obtained only by opening a switching device ahead.

Grounding—The primary duties of ground wires in high-voltage cable and in surface lines associated with such cable are (1) to operate ground-protective equipment, and (2) to keep equipment connected to the high-voltage circuit at as near ground potential as possible. Ground wires should be metallically connected to equipment frames. They should be continuous, they should be checked from time to time to see that they are continuous, they should be protected against stray DC currents, and they should be checked regularly to see that they are not carrying excessive stray current—on the order of 40 to 50 amp, which normally means a defective DC return. The final touch in good grounding is connecting each item of equipment served by the cable circuit to a driven ground near each unit.

The mine grounding system should be kept separate from the grounds serving the equipment and lightning arresters at the transformer station. This protects men in the mine from the possibility of shock from lightning outside.

Ground Protection—To limit the flow of current in a ground to, say, 25 to 50 amp, and thus also limit the voltage to which a man is subjected in coming in contact with a piece of equipment affected by a short or ground, customary practice is to connect the protective ground to the neutral of a Y-connected transformer secondary through a grounding resistor and current transformer, as shown in the accompanying diagram. The current transformer operates the trip coil to open the breaker. The same effect can be secured with a delta-connected secondary by using a zig-zag transformer to establish a neutral. To permit establishment of a grounded neutral it is recommended that the mine be served by a separate transformer station, even if the ratio is only 1:1. However, by proper switching and relaying, the mine station can serve certain other 3-phase loads.

The accompanying diagram also shows current transfers for detecting ground-fault current and opening the breaker within a few cycles not only to reduce the time men might be exposed to hazards but also reduce equipment and cable damage. Other methods of detecting ground-fault current include the "window" or "doughnut" transformer around the three power wires—but not

the ground wires—and the three-phase current transformer with single secondary.

Mine Power Selection

WITH LOCOMOTIVE or shuttle-car haulage, DC is a necessity for at least part of the mine load. DC also is a simple system and one that is well-known. However, the advantages of AC are numerous and substantial, and therefore, even if DC is retained for haulage, warrant careful consideration for other mine operations. In a dual system, standard conversion or step-down equipment may be used for both services or, as an example, where it is desired to have shuttle cars dump to a belt system, the primary system can be AC with small metallic-type rectifiers (selenium, germanium, silicon, etc.) for serving the shuttle cars.

AC advantages include the following:

Motor cost averages two-fifths the cost of DC motors.

Cost of 220-v AC control is about the same as DC; 440-v is less.

Portable AC substations are less than one-third the cost of DC conversion equipment.

AC equipment maintenance is simpler.

AC is more versatile. Therefore, it is easier to handle a variety of loads. For a small isolated unit, as an example, AC equipment includes a small combination substation and motor starter.

With AC, on the other hand, reactance and power factor must be taken into account along with the usual resistance and load current. Voltage drop during the starting period must be kept to not over 15% to insure contactor operation. With DC, the maximum drop is 20%. The speed of AC motors is not materially affected by changes in voltage—within reasonable limits—but the torque output is affected more than with DC motors because with AC it varies as the square of the applied voltage.

Voltage—As machine horsepower increases, the burden on trailing cables with 220- or 275-v power increases. In many areas, these are the maximum voltages permitted at the face. There are indications, however, that relief is in sight, though it still may come rather slowly. As an example, the new Indiana mine law permits up to 680 v at the face.

Where it is permitted, going to voltages higher than 220 or 275 should receive the most earnest consideration. With the same-size conductor and the same distance, twice the load can be handled with 440-v power compared to 220, for example. Conversely, with the same conductor size and load, power can be transmitted twice as far with the same voltage drop and losses.

DC Service

CONVERSION EQUIPMENT includes the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are under consideration.

Conversion Capacity—Higher horsepower per machine and per section is requiring an increase in the capacity of rectifiers and other conversion equipment. A recent series of tests on power required by continuous miners indicates that the capacity for a single section (miner and shuttle cars, roof drill, etc.) should be at least 200 kw.

Dull bits on miners and other equipment have a major effect on power demand and consumption. In one test with dull bits, miner advance was 20 ft, demand was 82.4 kw and consumption was 32.47 kwhr. Time was 50 min. With sharp bits, advance in 54 min was 30 ft. Demand was 69 kw and consumption was 31.33 kwhr (J. O. Cree, 1956 Coal Convention, American Mining Congress).

Automatic Operation—The high cost of labor naturally dictates making substations automatic unless attendants can grind bits, splice cables or perform other duties. Equipment now is available for checking position and operating breakers at will from a central station several miles away (*Coal Age*, October, 1955, p 68). The system is based on carrier current using telephone lines for transmitting audio signals.

Portability—For the maximum in convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations—to serve main-line haulage, for example. Or stationary types may be employed at some saving in cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities, even when offset by the cost of boreholes, warranted keeping conversion equipment on the surface, even with 275 v as the nominal voltage. With 550 v, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

The Inverted Trolley—For locomotive operation, a newcomer in service is the inverted trolley (*Coal Age*, October, 1952, p 87). As the name implies, the trolley is placed on top of inverted hangers, and the locomotives receive power through sliding shoes pulled by cables. Trolley poles and their cost and hazards are eliminated, including backpoling. There is better electrical contact with the wire, less wear on wire and collectors, and greater convenience with cable-reel units, since there is no need to change from pole to nip.

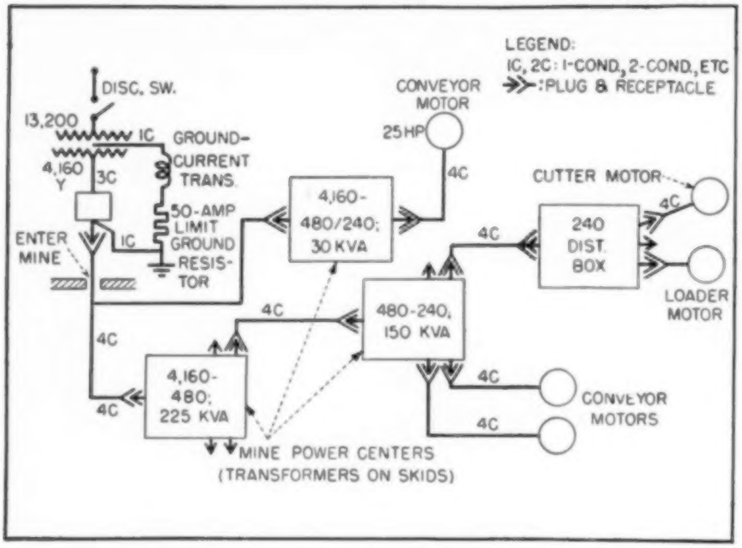
Transmission Limits

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance should not exceed 3,000 to 3,250 ft for an 800-amp average transmission, 300 v at the nips and 250 v at the machine.

Even with the maximum in feeder capacity it is difficult to maintain adequate voltage, let alone rated, for 250-v motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir. mils, 800 amp; 1,000,000 cir. mils, 1,230 amp; 1,500,000 cir. mils, 1,550 amp.

Aluminum Feeder—A decidedly lower relative cost makes aluminum very advantageous for bare feeders alongside trolley wires or elsewhere. It has greater bulk, however, and consequently the advantages are largely offset by the increased insulation and jacket when used for high-voltage power cables or low-voltage trailing cables. But with bare feeder, aluminum has about 70% the current-carrying capacity of copper, and 3 ft of aluminum feeder can be bought for the price of 1 ft of copper.

Edison System—One possible answer to the problem



THREE-VOLTAGE AC SYSTEM, showing outside substation, ground protection and mining equipment served.

of keeping substation moves down while keeping voltage up is the three-wire, or Edison, system (*Coal Age*, July, 1947, p 86).

Sectionalization

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.
2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermediate protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.
3. Insert a disconecting switch or protective device at intervals of not over 1,500 ft in all power lines.
4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operating mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.
5. Place an overcurrent protective device at each branch circuit.
6. Protect each circuit feeding a local section or territory with an overcurrent device.
7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.
8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.
9. Protect each mining setup with an overcurrent device.
10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, November, 1953, p 86. How to calculate load division as a guide to choosing breaker settings is detailed in *Coal Age*, August, 1955, p 55.
11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.

Ground Protection

The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

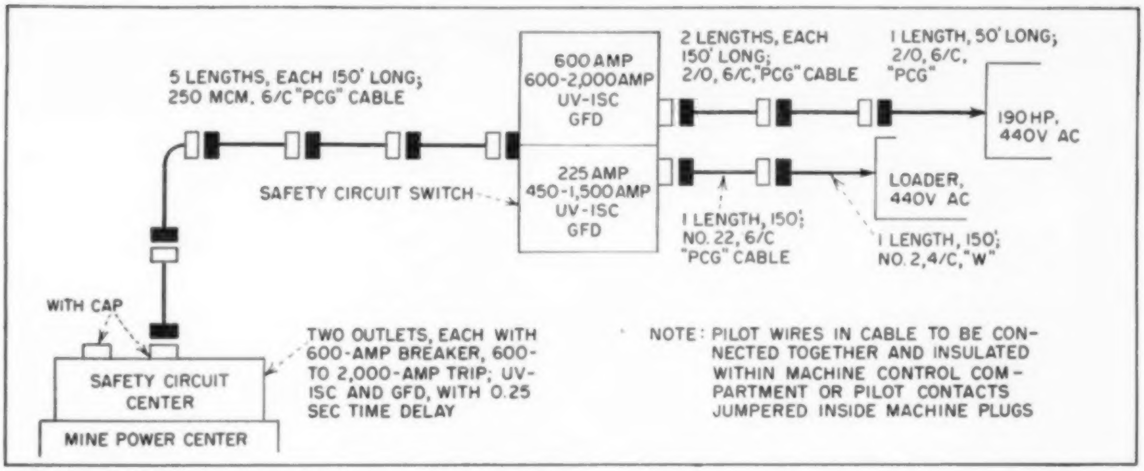
The best answer to this latter condition is a three-pole circuit breaker, with one pole in the grounding circuit equipped with a 5- or 10-amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high-intensity fault will be cut off before severe equipment damage occurs.

Proposed alternatives, particularly for such mobile units as shuttle cars, include the polarized relay, the polarized short-circuiting device and certain electronic devices (*Coal Age*, February, 1955, p 84).

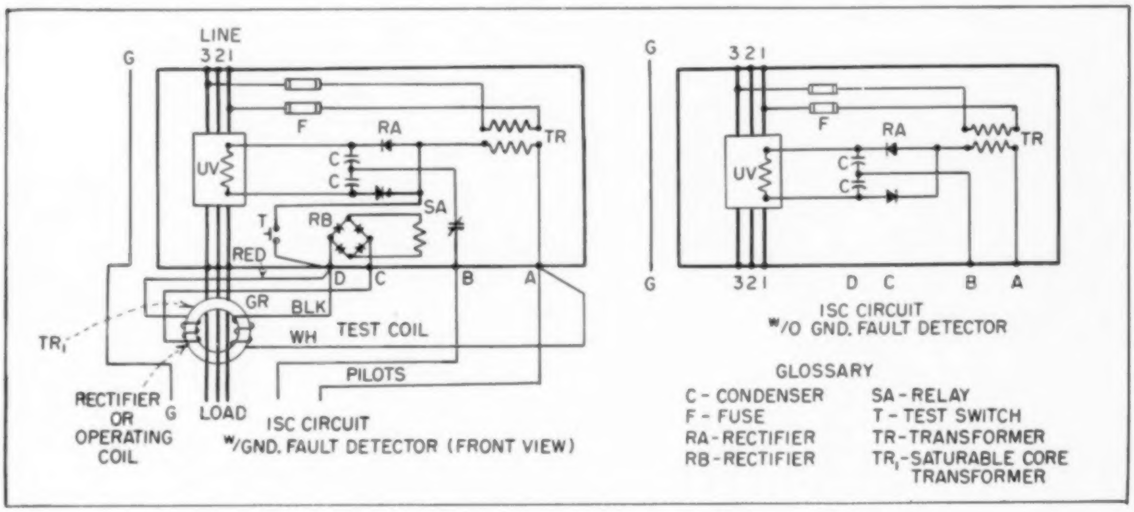
As a result of research in these directions, a number of units are now being offered for protecting mobile off-track equipment without the separate ground wire back to the main return, all meeting the requirements of USBM Schedule 2F.

AC Service

THE INHERENT HAZARDS of oil-filled transformers make non-flammable coolants a must where liquid types are employed. But even when the coolant will not burn, it still has weight and thus makes moving transformers more of a job, especially in thin coal. The dry-type unit has commanded increasing favor as a result. A variation



MODERN AC SETUP designed for higher voltages provides protection for men and equipment and permits ready circuit extension by sectionalized cable.



CONTROL CIRCUIT for modern AC system with and without ground-fault detector.

also finding greater use is the sealed nitrogen-filled transformer. As an example of the saving in moving time, one mine can take a three-unit 150-kva sealed-type station 1,000 to 1,200 ft in 3- to 4-ft coal in ½ to 1 man-shifts, compared to 10 man-shifts for conventional oil-filled equipment.

Distribution

The opportunity of using 440 v or higher at the face (up to 680 v in Indiana) considerably eases the problem of face distribution with AC. Where the limit is 220 (nominal), trailing-cable limitations make it impractical to transmit AC more than a few hundred feet. This requires the use of an intermediate voltage or frequent moves. The latter are facilitated in low coal by skid mounts and dry-type or sealed transformers to reduce weight.

Where an intermediate voltage is employed, it normally would be 440 (nominal), though it could be higher. With 500,000-cir. mil conductors, and taking into consideration moving and other costs, the practicable distance with 440 v is about 3,000 ft. How one three-voltage system is set up (*Coal Age*, September, 1955, p 91) is shown in the accompanying diagram. Among other things, the diagram illustrates the use of the grounded neutral system for protecting men and equipment summarized in the discussion of "Primary Power" earlier in this section.

Basic elements in a modern AC power-distribution setup underground are shown in the accompanying schematic drawings. It involves among other things an "intrinsically safe control circuit" using pilot wires in the cables to open the breakers and permit cables to be connected or disconnected between lengths or to power centers, circuit centers and junction boxes with no danger of incendiary arc. Undervoltage protection is provided at the same time. Ground-fault detection may also be provided by means of a detector coil around the power leads, a bridge rectifier and a sensitive relay (*Coal Age*, August, 1944, p 88). A pushbutton is provided for testing the circuit.

NEW HIGHS in shovel capacity and range are packed into this 60-yd machine that can move up to 110 ft of cover.

The Strip-Mining Guidebook

MANEUVERABILITY as well as flexibility and long dumping range are features of draglines.

MATCHED CAPACITY for stripping, loading and hauling adds up to more tons per day because of efficient operation.

Preparing for Operation

THE FIRST JOB in planning a strip mine is to find out how much coal is available and where it is. There are a number of ways of doing this and the following questions should be constantly in mind as preparation is made for operation:

1. Who owns the surface and mineral rights in the area being considered?
2. What does the land look like—how does it lay?
3. What will be required to get the coal out once a suitable area is blocked out and prospected?
4. How does the coal analyze?
5. What are the seam conditions?
6. What kind of material covers the coal?
7. Are there any restrictions on the use of the land? What about restoration of the surface after stripping is completed? Is there the danger of slides damaging adjoining land? Are there pollution problems to be considered?
8. What will the mining costs be?
9. How much will the coal sell for?

Aerial Surveying

Good maps are the foundation for gathering and assembling information before starting mining. An aerial survey from which accurate maps of all types can be made is the latest tool for studying prospective stripping sites. And the cost is only about half that of the ground survey. Because of the multiple uses for aerial maps and photos, they have become more and more popular.

Aerial mapping also is more flexible than ground surveys and the same set of aerial negatives can be used for three jobs. They can be used for stereoscopic study of the land under consideration. They can be grouped into a mosaic which makes a good reconnaissance map. Then, when the area of interest is defined, a contour map can be made from the aerial photographic base. The speed with which these maps can be made is a major advantage.

An average topographic map can be made up in one-half to one-fifth the time needed for ground surveys at a sizable savings in cost and with no sacrifice of accuracy. With an aerial topographic map, an engineer can estimate coal acreage, plot crop lines, spot boreholes, determine and locate spoil areas, lay out haulage roads, compute overburden ratios and plot property lines.

A minimum of surface or ground control is needed in aerial topographic mapping. In some cases existing control may be entirely satisfactory. In others, it may be necessary to establish vertical control points for each photo and several horizontal control points along each flight strip.

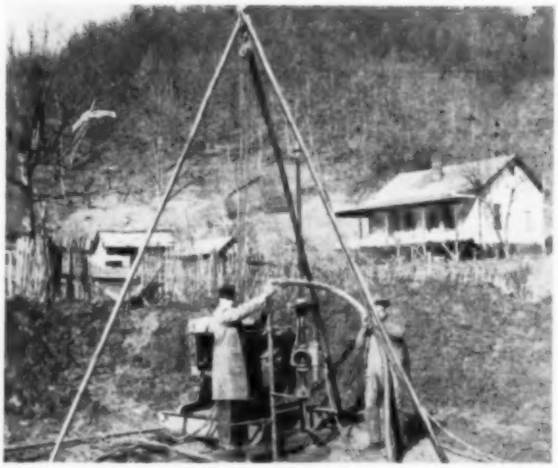
When it is not practicable or desirable to have an aerial survey made, a ground survey may be required, particularly if there has been no previous mining in the area. The extent of the survey will depend on the lay of the land and how much information is already available, such as, topographic maps and geologic bulletins. If deep mining was done in the area, mine maps will provide a valuable source of information and will reveal a great deal about the nature of the coal. First, they will show how much, if any, coal is left between mine workings and the outcrop. Seam characteristics, including dip, thickness, unusual conditions and so on probably will be shown.

Prospect Drilling

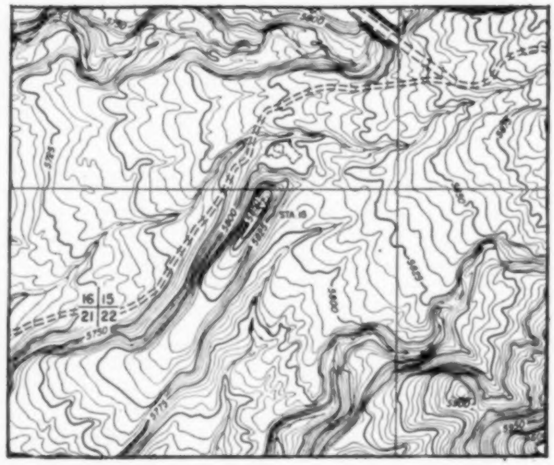
The next step after mapping is to assemble as much information as possible about the coal seam and mining conditions. Drilling is the most satisfactory method of prospecting coal for full and accurate information. This can be done either by churn or diamond

Where to Find It in . . .

The Strip-Mining Guidebook



CORE DRILLING of prospective strip land assures accurate record of strata.



GOOD MAPS made from aerial surveys can provide low-cost information for opening new mines.

equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information. A churn drill in the hands of a skillful operator also can provide accurate data but is no proof that it is accurate. A coal core, on the other hand, can be examined visually and half of it sent to the laboratory for complete analysis. The other half can be kept for reference.

Development of a bottom-discharge bit that prevents air circulation around the core has made possible the successful application of air core drills. Air coring is said to make possible 100% core recovery nearly every time, even when it is necessary to stop half way through a seam. In soft, friable coal at least a 4x5½-in core barrel is needed to prevent the core from breaking and falling out. A very important advantage of air coring is that thin, soft partings of clay or other material are not washed out as they would be when using water. Another advantage is that water lines and pumps are eliminated.

In any drilling program, sufficient holes should be drilled to get an accurate picture of the coal bed. The drilling results should be plotted on the property map along with other key data. Isothickness lines should then be added to the map.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

As prospecting information is accumulated, it should be put on a prospecting and property map developed from a topographic map base. Such a map will give a "bird's eye" view of the potential of the proposed stripping area. As the picture on the prospecting map takes shape, decisions can be made as to where more prospecting is needed and how much.

The possibility of having a second valuable mineral present in the strip pit should be carefully checked. Some coal companies have added significantly to income by recovering at little or no extra cost fireclay under the coal and shale over it. (*Coal Age*, June, 1955, p 72). These profit makers may be the difference between a marginal operation and a profitable one.

Plant Layout

If a new preparation plant must be built, the first job is to pick a site for it. Choice of a location is governed by access to rail facilities, suitable building space and nearness to the coal to be mined. Where possible, the plant should be centrally located so haulage distances will be as short as possible.

After the plant site is selected, the point to attack the coal seam should be selected. Then a permanent haulage link should be laid out to connect the preparation plant with the pit. A preliminary road layout can be made on a topographic map, along with estimates of the earthwork involved in building it. The field work then will consist of marking off the road route and making any minor adjustments.

In arriving at a permanent road layout, it should be remembered that good alignment and grades will pay off in faster haulage and lower truck maintenance. A solid, well-drained roadbed should be standard practice in all road design. Trucks should be able to travel at top speed whether loaded or empty, and drivers should be able to see clearly on all curves.

The mine layout will be governed by a combination of factors: type and contour of the overburden, coal thickness, coal quality and the quantity available. If the coal lies below drainage, a box cut will have to be made to gain access to it. If the coal is to be mined by following the contour or outcrop, a considerable sum of money may have to be spent to build roads to the coal level. If it is not desirable or feasible to haul coal downhill to the preparation plant, a bin feeder and conveyor setup will be needed at the dumping point to link it and the cleaning plant. The final selection of method will have to be made after a careful analysis.

Selecting Equipment

Closely linked to the mine layout is the selection of equipment for all phases of the operation. Natural conditions along with economic factors will largely determine the type and size of equipment to be used. The key question will be how many cubic yards of waste material can be economically handled to recover a ton of coal. Today there is no simple or magic formula that can be applied to determine the economic stripping limit. A realistic set of estimated cost figures is the best guide. When the limit is determined, equipment capa-

HIGH CAPACITY rotary drills perform heavy-duty work in thick cover.

MOBILITY plus fast drilling are advantages of smaller rotary machines.

ELECTRIC MEASURING DEVICE in drill cab records hole depth accurately.

SIDEWALL DRILL is an effective unit where the cover is not too thick. Units are either mounted on truck bed or are self-propelled on wheels or crawlers.

ble of working to the limit can be considered.

To help in the selection of stripping equipment, it is wiseto draw profiles of the proposed stripping area along with equipment dimensions and ranges. This type of diagram will show how wide the pit can be made, what the spoil bank will look like and how each type of equipment can be used most efficiently. Some of the factors affecting the selection of key stripping units will be the tonnage of coal desired per shift, surface features, available spoil area and type of overburden.

The reserves of coal available for stripping also will play an important role in the selection of equipment. There must be enough coal owned or under lease to permit amortization of the capital investment over a reasonable period of time. It could be unwise to develop a mine with small-capacity equipment when there are ample reserves that can be recovered more economically with high-capacity units. Contrariwise, it would not be good judgment to buy big expensive machines if there are not sufficient reserves to set up a reasonable depreciation rate. Before making a decision on the type of equipment it is sound policy to have a series of meetings between engineering, operating and manufacturers' representatives to consolidate ideas.

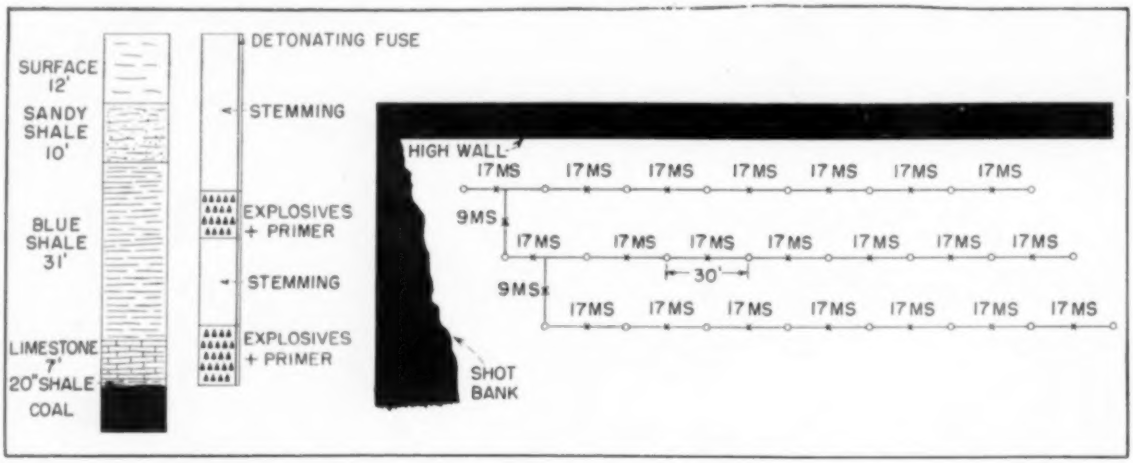
After the stripping machine has been selected, other units, such as, drills, coal shovels and trucks, should be chosen with capacity geared to the stripping unit. Matched equipment is necessary for smooth, efficient operation and therefore low-cost mining.

Radio—Where mining plans call for the various machines to be working far apart or in more than one pit, strong consideration should be given to installing a radio communication system. Money spent on the radio setup frequently can be repaid in better supervision and less equipment down time. For example, time lost by equipment in the pit can be substantially reduced because stripping units can report trouble immediately. Therefore repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling. If an emergency order for a part must be sent to the factory, word can be sent to the mine office and immediately relayed by phone to the factory. Frequently the part can be on the way to the mine by plane in less time than it would take to drive from the pit to the office to telephone.

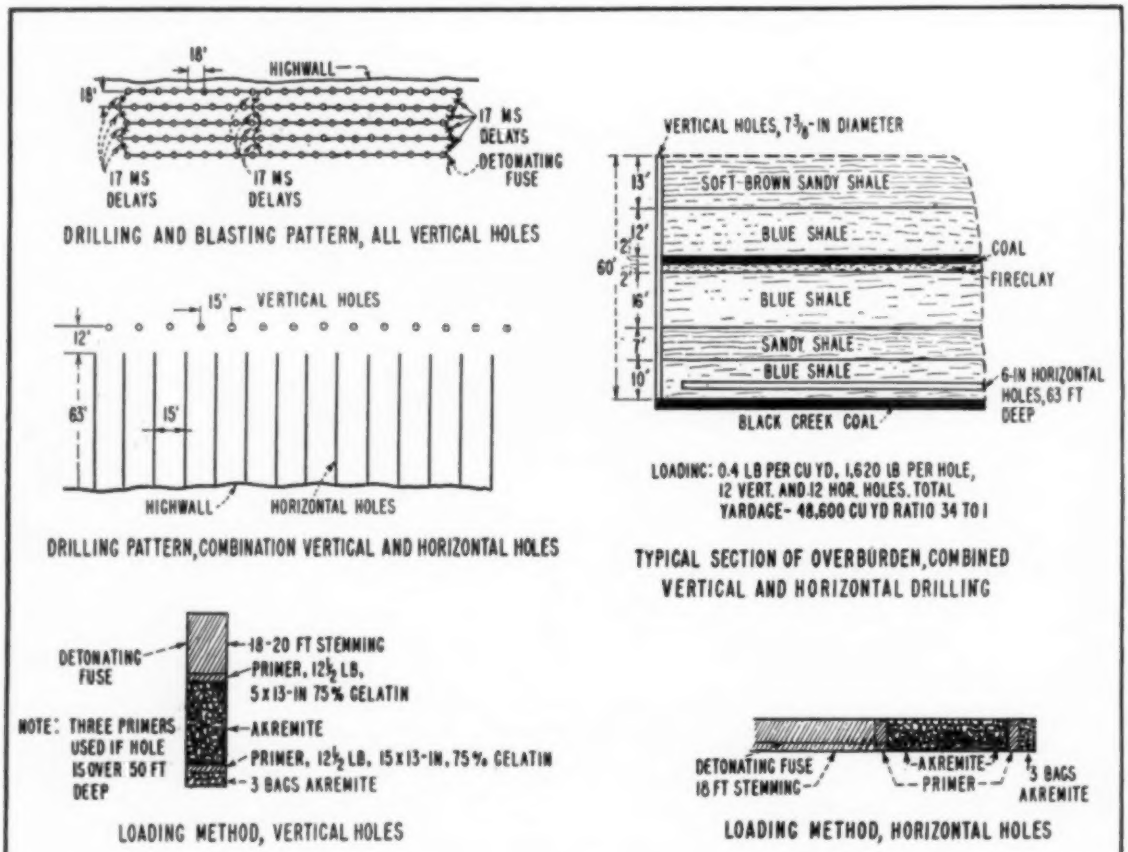
Another important benefit of radio communication grows out of the fact that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

Overburden Preparation

THE GOAL in overburden preparation is to break up the material as fine as necessary to permit easy handling by the stripping unit. The ideal condi-



TODAY'S DRILLING AND SHOOTING PATTERNS include vertical and horizontal holes or a combination of them to get the best fragmentation for easier stripping. Careful study is required before selecting a pattern.

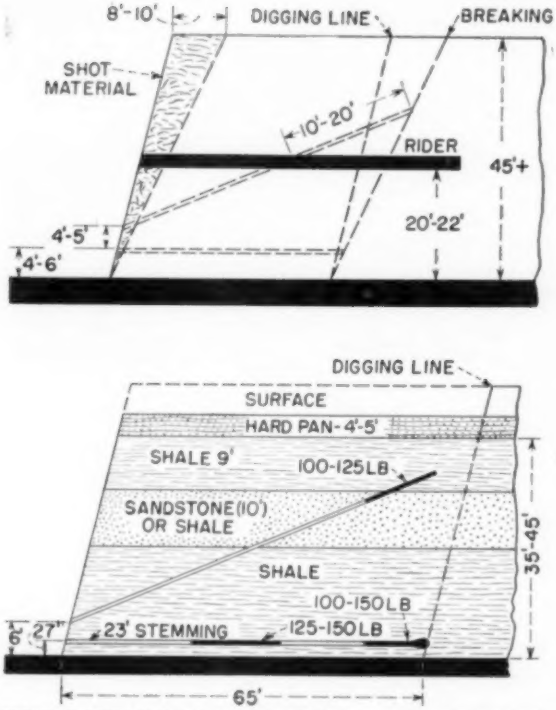


tion would be to have the overburden broken down into gravel-size pieces to permit low-cost handling with smaller equipment than required for moving larger-size material or boulders. However, since the cost of drilling and shooting, including labor, to pulverize the material normally would be prohibitive, fragmentation must be looked at from the standpoint of over-all cost.

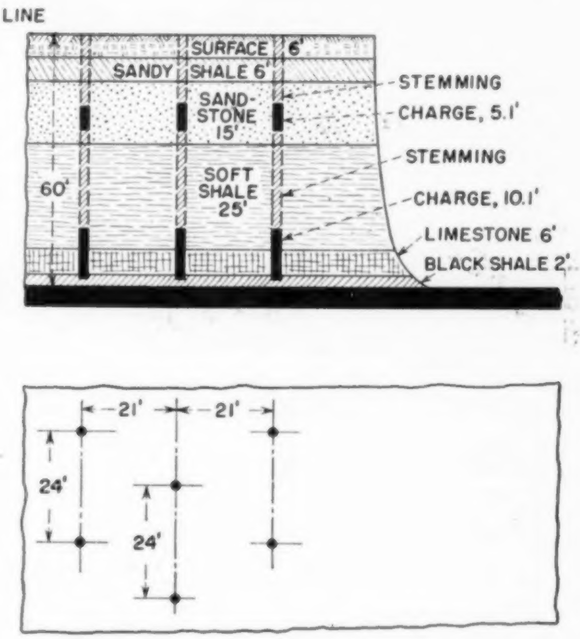
Drilling Rock

Maximum fragmentation with a minimum of labor, equipment and blasting can be achieved with high-capacity drills sinking holes in a good pattern, plus the proper breaking medium properly applied and detonated. An increasingly popular machine for drilling overburden at large-capacity

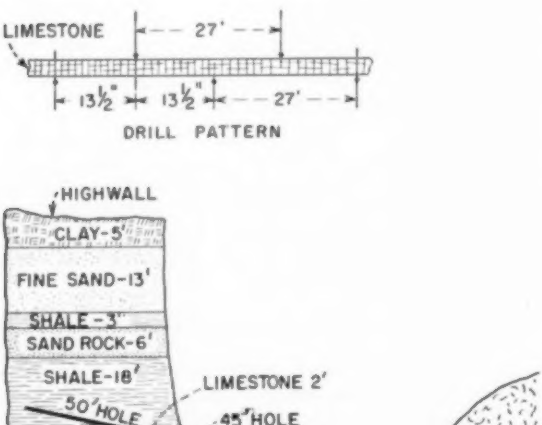
How Some Operators Tackle Unusual Shooting Problems



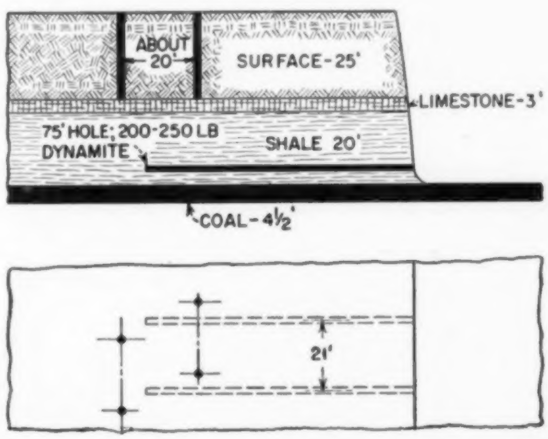
HOW DOUBLE-DECK SHOOTING can be used to break banks with hard or tough materials in the top. In the plan at the bottom, use of two holes reduced fine coal output by 10%, cut the quantity of explosive needed and enabled the dragline to work to the full depth of the holes, thus gaining 5 ft on each cut. In the system shown at the top, the explosive charge in the upper hole is brought farther toward the front of the bank and to provide sufficient resistance a layer of shot material is left.



BLASTING the highwall is a tough job in this pit. Holes are drilled in diamond pattern and explosives are concentrated in hardest layers of rock. By placing separate charges in the hard sandstone and limestone layers, explosives are used most efficiently and better fragmentation is achieved. Changes in thickness of either the sandstone or limestone are watched carefully and the quantity of explosives is increased or decreased as required. Accurate logs of all blastholes are kept to serve as a guide in loading explosives.



AN EXAMPLE OF HIGHWALL DRILLING in the pit with horizontal auger drill. Alternate holes are above and below the limestone.



THIS RATHER UNUSUAL JOB of highwall shooting features vertical holes to the limestone to break it so the horizontal shots can heave the overburden the full depth of the horizontal holes. All shots in or near a vertical plane through the horizontal hole are fired together. The farthest-in vertical hole is slightly beyond the bottom of the horizontal hole.

LOW-COST blasting mediums have reduced overall explosives costs and improved fragmentation to boost stripping efficiency.

VERSATILE TRACTOR-SCRAPERS can cut down 30 to 35 ft of cover and haul it several hundred feet.

mines with thick cover is the large rotary dry-type drill. Capable of drilling a 12-in hole, development of these drills reflected industry demand for a machine that would function more efficiently than the churn drill in thick, tough rock. This became much more important in recent years as more power and capacity was packed into stripping units and pressure for keeping them working at full capacity became greater. In a typical installation at a large stripping operation, a three-man crew with one large rotary dry-type unit drills 1,000 ft of 10⅝-in hole and shoots better than 30,000 cu yd of overburden in a shift, permitting a dragline to move better than 1,000,000 cu yd in a month (*Coal Age*, March, 1953, p 80).

Big drill advantages also include an opportunity to use less-dense, lower-cost blasting mediums. Others are better fragmentation; less explosives per cubic yard of material broken; clean, smooth holes; and excellent stemming from drill cuttings.

The success of the high-capacity drill created a demand for the same type of drill in a lighter, smaller, more mobile and less expensive package for use at smaller operations. To meet this demand, a series of truck- or crawler-mounted drills have been designed and built for the smaller operator whose output is less than 2,000 tpd. Capable of penetrating rock at the same speed as the big units, the smaller drills are available to fit the needs of the smaller producer.

In recent years there has been a distinct trend to vertical drilling as overburden has become thicker and harder. There are several reasons for this: (1) a better chance for getting better distribution of explosives throughout the overburden; (2) more opportunity for getting explosives into hard layers where they are needed most, though some two-level horizontal drilling is achieving the same goal; and (3) reduced drilling footage where cap rock or other hard layers must be broken.

The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin, or where tough rock lies close to the coal. In some cases they are used effectively for two-level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectively to drill near a strata whose position over the coal varies up and down. They also have the advantage of easy leveling in an uneven pit. Tractor-mounted percussion units for special conditions, such as a thin, hard layer of rock between two coal seams should not be overlooked in seeking low-cost bank preparation.

When difficulty is experienced with the hole squeezing together in the portion drilled through clay or soil with a rotary vertical unit, it can be overcome by augering through the soft material and then changing to the regular roller bit. Although this requires two extra tool changes, the faster penetration of the soft material and the elimination of trouble resulting from squeezing will pay. At one Illinois operation this method of drilling resulted in a savings of $8,000 per year in bit cost.

At some mines auger stems are being used successfully with rotary dry-type machines to help bring the cuttings to the surface.

An added starter in the overburden drilling field is a crawler-mounted rotary unit that features mobility in rugged terrain and an infinitely variable hydraulically driven rotary head that permits regulation of speed to meet varying conditions.

Vertical augering machines have been improved to the point where they can drill a 9-in hole in coarse-grained sandstone to a depth of 100 ft. Operating through a multispeed transmission, drill rotation can be regulated according to the toughness of the rock. Up to 600 ft of hole per shift can be drilled with this machine.

To meet the need for a horizontal unit to drill materials too hard for auger-type machines, a rotary machine has been developed. The drill bores a 7¼-in hole and has a maximum thrust of 40,000 lb on the bit. This machine was developed primarily as a result of a need for a machine to drill hard rock close to the coal.

Breaking Rock

Efficient overburden preparation boils down to getting the right charge of explosive in the right place. A careful study of the overburden and constant checking of field results is the answer to effective rock breaking. Sometimes a particular type of rock can be broken best with a heavy charge in large-diameter holes spaced far apart. In other cases, smaller charges in smaller holes spaced closer together will provide better breakage. A combination of vertical and horizontal holes produces the best results at other times.

In selecting the right explosive for a job, engineers and operators must consider the physical characteristics of the bank, its height, the material, drilling equipment available, digging

equipment to be used and then select the right product to give maximum fragmentation. The drilling pattern will depend mainly on the foregoing factors.

Shale overburden usually can be blasted successfully with a single row of horizontal holes if they are large enough to permit the proper loading ratio. A single row of holes should be drilled so that the resistance of the material above the holes will roughly equal the resistance of the material between. As banks increase in height, it becomes necessary to increase the size of the hoie, since holes drilled close together tend to shear horizontally rather than exert force upward to produce the desired fragmentation. For deeper cover it is possible to use high and low horizontal holes or to combine horizontals with verticals.

Where overburden is over 50 ft, vertical drilling generally is considered best. Two-level horizontal is usually too costly and single-level is inadequate.

Aside from varying the drilling pattern to meet the needs of individual pits, the method of distributing the charge in the hole can affect the blasting efficiency. With some types of rock, full-column loading produces the best results. With others, deck loading gives better fragmentation.

Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yards of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change. The goal in blasting is to get maximum fragmentation at minimum cost and thereby permit the stripping unit to move more material with less effort.

One company has developed an electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes (*Coal Age*, May, 1955, p 122). The operator can look at the hole log, tell how tough the rock is and then determine how much explosives will have to be used to get the best results.

Delay Shooting — Delay shooting usually will permit explosives to do a better job. At many mines milli-second delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas. The progressive relief possible with delays also permits the explosives to perform more efficiently.

As overburden becomes thicker, the problem of vibration and shock becomes greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

The MS connector essentially is a piece of detonating fuse with a millisecond delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away (*Coal Age*, June, 1951, p 86).

A further advantage includes a 15% speed-up in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the reduced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used.

To reduce the quantity of detonating fuse and the number of MS delays required to set off a large number of holes, an Ohio operator is experimenting with a blasting timer that can detonate explosives at predetermined intervals. Complicated wiring is eliminated by a cable that connects the lead wires to the timer.

Blasting mediums in use today include various types of high explosives; liquid oxygen; and newly developed lower-cost blasting agents, such as, Akremite (*Coal Age*, May, 1955, p 70).

Most of the explosive manufacturers now are producing Akremite or similar blasting agents. New entries in this field include the following: (1) Nitro - carbo - nitrate which contains technical-grade ammonium nitrate instead of commercial grade. It is not cap-sensitive, and therefore a primer must be used to set it off. Speed is about 11,500 fps; (2) Unimite and (3) Methanite which contain technical-grade ammonium nitrate, coal dust and nitromethane. The nitromethane acts as a sensitizer for the ammonium nitrate and under certain conditions it is not necessary to use a primer. Speed is about 13,000 fps.

Significant improvements in manufacturing techniques have resulted in lower prices for liquid-oxygen explosives. Having a speed of 17,000 fps, this explosive has been very useful in breaking high banks containing massive sandstone.

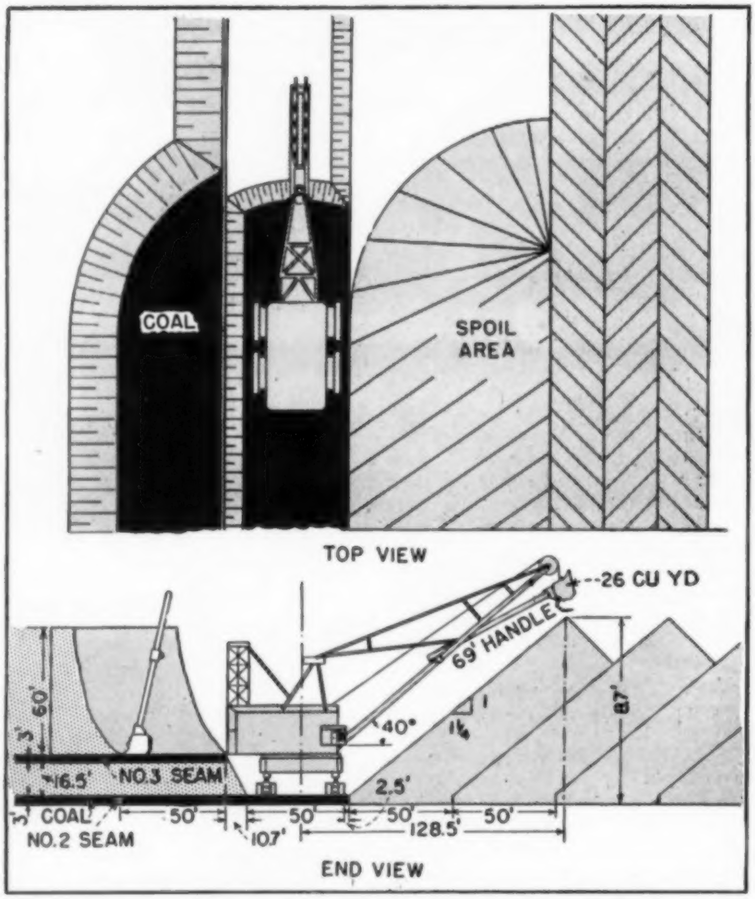
The characteristics of the rock and the drilling and stripping equipment control the type and quantity of the breaking medium needed and therefore no hard and fast rule can be made. In general, a dragline will require finer broken rock than a shovel, and the larger the stripping unit, the larger the size of material that can be handled economically with it.

Stripping

AFTER THE BEST DRILLING and shooting patterns have been set up, the right use of equipment for handling the overburden must be considered. The goal in uncovering coal is to have the stripping unit remove as much material as possible in a shift. Output alone is not the only factor to be considered in selecting the stripping unit. It must be suited for the job.

Box-Cutting—Opening a pit by box-cutting involves digging down to the coal and then working straight ahead to the limit of the property. By exercising care in opening a new strip pit along the property line in flat or gently rolling land it is possible to recover practically all of the coal in the tract. In some instances where a shovel or dragline is used to open a new tract along an adjoining property the first-cut spoil is placed on the surface next to the property line. Stripping then advances into the tract and the coal along the property line and under the first-cut spoil is left in place. Some operators do not consider it economically possible to rehandle spoil from the opening box cut and the regular material over the coal. As a result, the strip of coal along the property is never recovered. If a strip of coal 75 ft wide, 4 ft thick and 8,000 ft long is left in place along the property line, the loss will be about 37,000 tons.

The possibility of using auxiliary earth moving equipment, such as, scrapers and bulldozers to move the spoil from the opening box cut should be investigated thoroughly. For example, it might be possible to start at the property line and cut down 10 to 20 ft of material with scrapers and



TWO-SEAM STRIPPING from one position is done effectively with shovel designed to meet natural conditions.

spread it in a thin layer 4 to 5 ft thick over the surface where it can be easily rehandled in subsequent cuts. The scrapers could open the area by making a cut 100 to 200 ft wide along the property line. Exact width of cut can be laid out to fit into the overall plan for the regular stripping machine. It may be desirable for the auxiliary machine to cut down an area that is two or more times the width of the cut that will be taken by the shovel or dragline.

If the resulting pile is too high to be moved efficiently by the shovel or dragline when the second cut is made, a bulldozer can be teamed with it to level and spread the material in the spoil area. Or if the material is broken finely enough, it also might be possible to use scrapers effectively in the spoil area. The cost of rehandling the first-cut spoil should be weighed against the value of the coal left in place and the effect on the cost of handling overburden over the life of the mine.

Bulldozer Stripping—As a result of more speed and power being built into today's bulldozers, they are being used successfully as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Latest models available to the industry include single-engine units powered by engines delivering 230 hp and twin-engined models powered by two 190-hp diesels. Drawbar pull in the range of 60,000 lb or better is a feature of the new high-powered tractors. Modern tractors are available with either torque converters or direct drive.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be drilled and shot fine enough so that the bulldozers can move it easily.

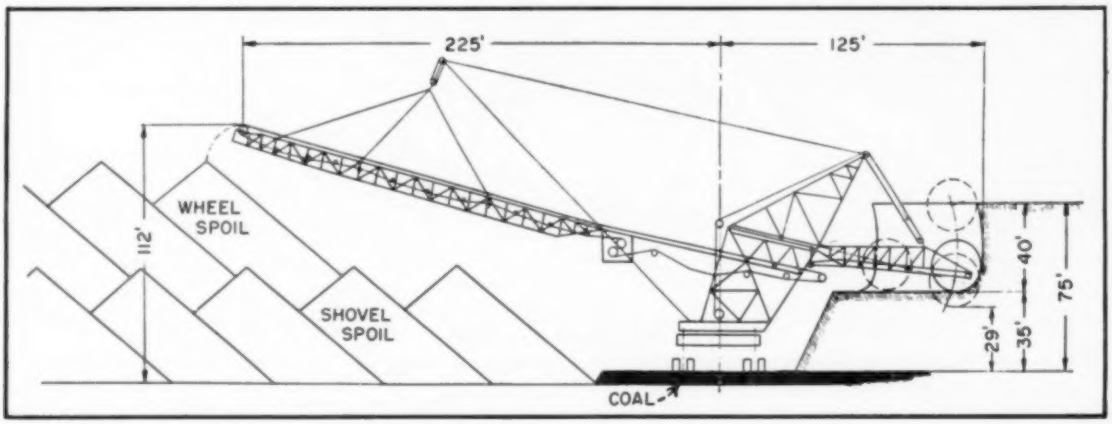
Another possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and takes off 10 to 12 ft of loose material—sometimes up to 20 ft (*Coal Age*, January, 1954, p 82). The shovel is used to remove the more solid material down to the top of the coal.

After a sufficient area of coal is uncovered, the shovel can double as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility or cleanup work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

Scraper Stripping—It is possible that conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank. However, the available shovel or dragline may not be able to handle the overburden in one pass. Consequently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a rooter that can be taken over the ground ahead of the scrapers to break up the ground.

Tractor-scraper units can be used to make an opening cut and working bench for a dragline (*Coal Age*, June, 1949, p 94), or remove up to 35 ft of overburden (*Coal Age*, August, 1953, p 74). The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example,

WHEEL EXCAVATOR extends stripping limit by removing top 40 ft of soft material and discharging it 350 ft away on spoil pile. Sketch below shows how wheel removes upper portion and casts it well beyond edge of shovel spoil.



five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden. A very worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

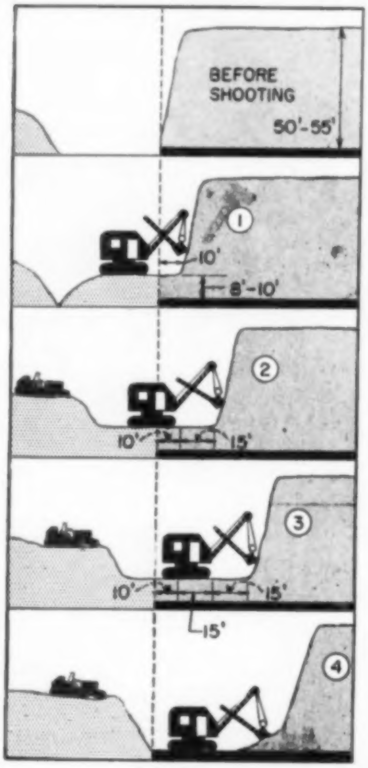
Shovels and Draglines—Shovels are available in a wide range of designs and capacities to meet all stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and 20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120-ft boom and 79-ft dipper handle can cut to a height of 107 ft. The 60-yd shovel which went into service this year has a 150-ft boom and can pile spoil 97 ft high. In between these two extremes are a series of units to meet all the conditions where shovels are applicable.

Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and pile spoil 98 ft high above the tub. In between these sizes are a host of machines that can handle nearly any assignment.

Big shovels in the 33- to 50-yd range usually work to a maximum of 70 or 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel; and in overburden between 50 and 80 ft, about 25% more than an 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be auger or deep mined. However, it must be remembered that the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

How to Move 55 ft of Overburden With Small Equipment



CAN COAL BE RECOVERED efficiently from under 55 ft of overburden with a 2-cu yd shovel and a bulldozer? At best, that is a difficult question to answer. But it can be done. Here is how one company teamed a 2-cu yd shovel and a bulldozer to move up to 55 ft of overburden. At the same time, backfilling was coordinated with stripping, leaving little additional work to be done to meet the requirements of the state mining law.

These are the steps in the stripping and backfilling operation:

1. After the overburden is shot, the shovel makes a working bench about 10 ft above the coal (Sketch 1). The shovel casts spoil ahead of it into the pit, taking a 10-ft vertical slice from the shot bank.

2. Next it moves to the highwall and starts a second bite, this time taking a 15-ft slice. Spoil is cast as far as possible.

3. After this slab is removed, the shovel again moves toward the highwall and starts a second 15-ft bite. After this slice is taken, the pit is 40 to 45 ft wide.

4. The remaining 8 to 10 ft of material in the pit is removed by the shovel from a position in the middle of the pit.

While the shovel is stripping, the bulldozer works in the spoil area, keeping the material pushed away from the shovel and leveling the area. The result is a uniformly sloping spoil area that requires little or no additional work to meet the requirements of the state mining law.

Operating Stripping Units

To get the maximum return from the investment, the stripping machine must be kept working as much as possible, and with no lost motion. To assure the best from shovels or draglines, some companies have installed swing recorders to indicate work time and the number of swings per shift.

More efficient engines for tractors, trucks and stripping machines now are available in the form of turbodiesels. A turbodiesel is a conventional diesel engine to which a turbocharger has been added to convert wasted power in the exhaust gases into useful energy. By forcing more air into the cylinders, the turbocharger makes possible more efficient burning of a greater fuel charge, thus creating more horsepower. Advantages cited for the unit include more work on the same quantity of fuel; more power, which permits better performance; and more power per pound of engine.

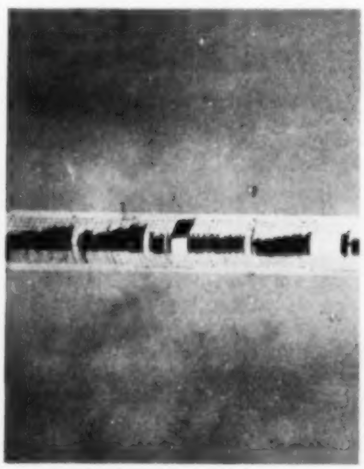
Another important factor in good machine operation is reducing cycle time to a minimum. The time consumed in loading, swinging, dumping and returning for a new load must be kept to a minimum. Proper planning of spoil areas goes a long way toward keeping the swing arc as short as possible as the machine rotates between pit and spoil area.

The key to fast loading is a well-prepared bank and the finer the material the faster it can be loaded. But it must be remembered that there is an economic limit to spending money for explosives to break the rock into fine pieces. Each operation must be examined carefully before a decision is made as to how much fragmentation is economically feasible.

Upping Dragline Efficiency — Machine output can be maintained at a high level if the operator handles it in a manner to get the best digging efficiency with minimum power consumption. It is sound practice to analyze the work of the dragline to determine if the operator is getting the most out of the machine.

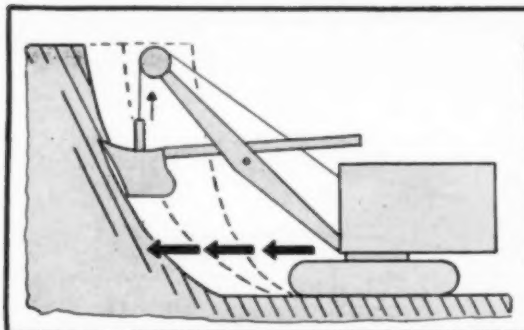
Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers

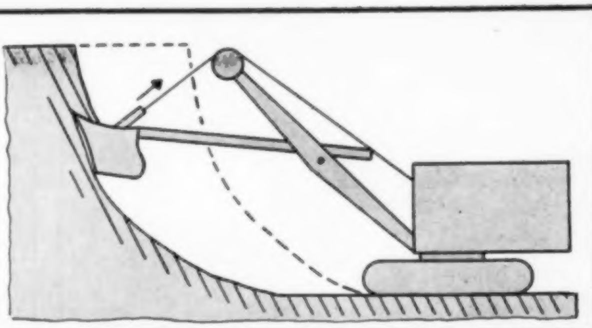
LOAD INDICATOR in operator's cab shows when dipper is full or overloaded.



SWING CHART records degree of swing and number of swing per shift.

RADIO COMMUNICATION is a big booster toward efficient performance.

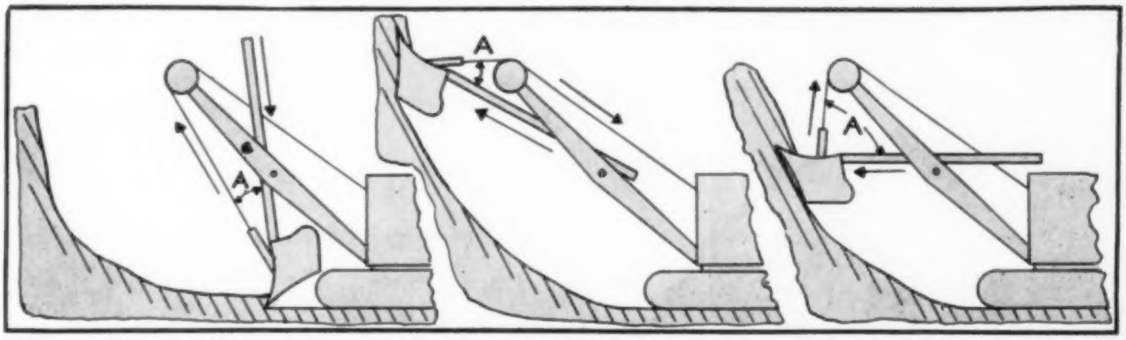




EFFICIENT METHOD—Move up. Keep close to face but not too close to beat-up track with dipper.

INEFFICIENT METHOD—Reaching for the work instead of moving up.

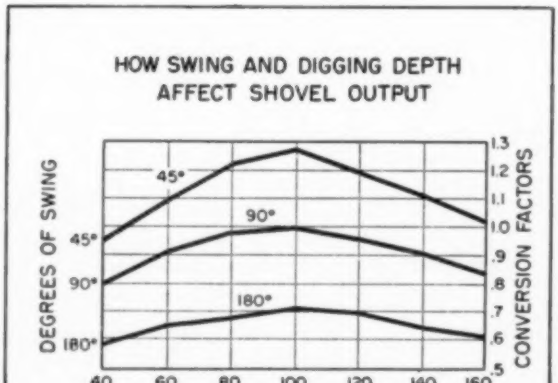
Tips On Better Shovel Operation



BAD . . . little or no hoisting force in line with cut—crowd action opposes hoist action.

BAD . . . very little hoist power available for cutting—hoist action opposes crowd action, over-strains dipsticks and shipper shaft.

GOOD . . . hoist and crowd actions work together resulting in faster action.



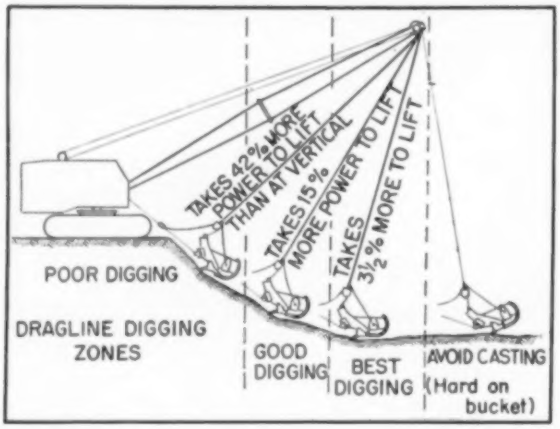
Effect of Depth of Cut and Angle of Swing on Power Shovel Output

Depth of cut in % of optimum	Angle of swing in degrees 45°	60°	75°	90°	120°	150°	180°
40...........	.93	.89	.85	.80	.72	.65	.59
60...........	1.10	1.03	.96	.91	.81	.73	.66
80...........	1.22	1.12	1.04	.98	.86	.77	.69
100...........	1.26	1.16	1.07	1.00	.88	.79	.71
120...........	1.20	1.11	1.03	.97	.86	.77	.70
140...........	1.12	1.04	.97	.91	.81	.73	.66
160...........	1.03	.96	.90	.85	.75	.67	.62

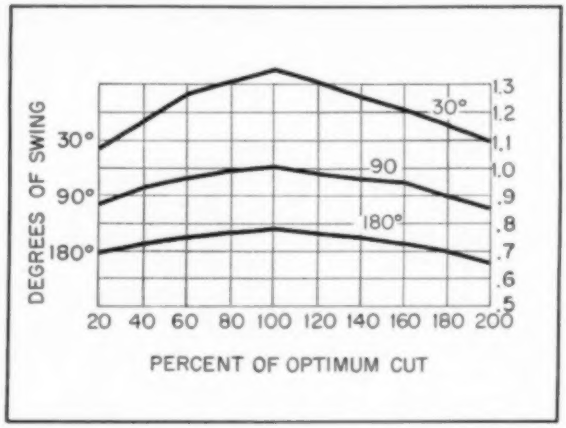
Conversion factors when applied to the output of 90-deg swing and optimum depth of cut, will give the output at other angles of swing or depth of cut for dragline and shovels.

will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digging area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By

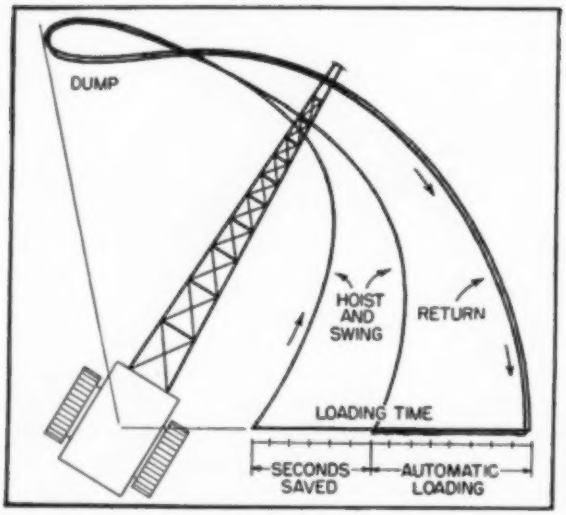


HOW dragline operation affects power and digging.



HOW swing and digging depth affect dragline output.

Method of operation, angle of swing and digging depth are key factors in getting dragline efficiency.

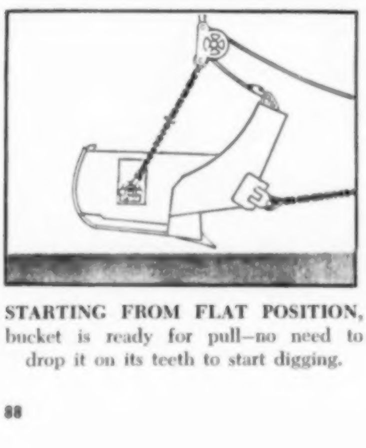


GOOD BUCKET DESIGN cuts loading time from 14 sec to 8 as a result of improved digging ability.

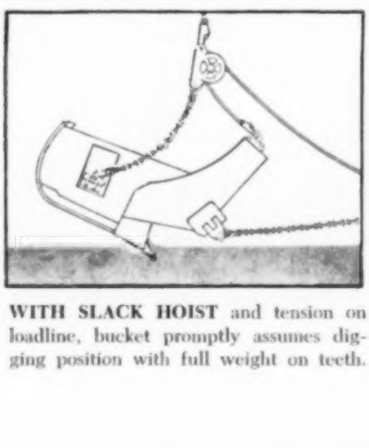
Effect of Depth of Cut and Angle of Swing on Power Dragline Output

Depth of cut in % of optimum	Angle of swing in degrees 30°	45°	60°	75°	90°	120°	150°	180°
20	1.06	.99	.94	.90	.87	.81	.75	.70
40	1.17	1.08	1.02	.97	.93	.85	.78	.72
60	1.24	1.13	1.06	1.01	.97	.88	.80	.74
80	1.29	1.17	1.09	1.04	.99	.90	.82	.76
100	1.32	1.19	1.11	1.05	1.00	.91	.83	.77
120	1.29	1.17	1.09	1.03	.985	.90	.82	.76
140	1.25	1.14	1.06	1.00	.96	.88	.81	.75
160	1.20	1.10	1.02	.97	.93	.85	.79	.73
180	1.15	1.05	.98	.94	.90	.82	.76	.71
200	1.10	1.00	.94	.90	.87	.79	.73	.69

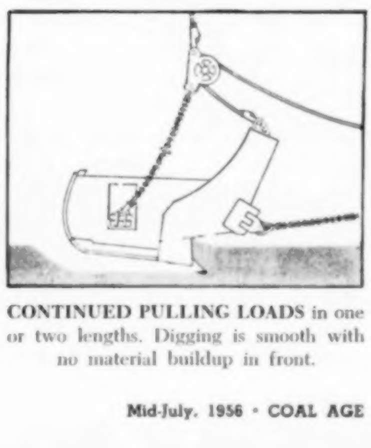
How a Well-Designed Dragline Bucket



STARTING FROM FLAT POSITION, bucket is ready for pull—no need to drop it on its teeth to start digging.



WITH SLACK HOIST and tension on loadline, bucket promptly assumes digging position with full weight on teeth.



CONTINUED PULLING LOADS in one or two lengths. Digging is smooth with no material buildup in front.

hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Side pulling with the boom overheats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

Bucket Maintenance—Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to be avoided are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing to permit worn units to be built up with hard-surfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

Shovel Operation—As with dragline loading, the bank should be removed in slices in shovel work, also. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Load indicators also are gaining in favor to show the operator when the dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overloading and therefore fewer breakdowns.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

Pit Cleaning

Pit cleanup should not be done at the expense of reducing the operating efficiency of the stripping unit. It must be remembered that the goal in stripping is to keep the stripping unit working at full capacity. A great deal of valuable time can be lost by attempting to clean up widely scattered boulders that can be cleared from the coal by an auxiliary unit, such as a bulldozer. The money spent on an auxiliary dozer and operator in most cases will be more than repaid by an increase in output of the stripping unit and therefore in coal output.

However, it usually is more economical to have the stripping unit scale down loose material on the highwall as stripping is done than to trim the wall later with the coal-loading unit. In some cases, particularly where the cover is thick, it may be impossible for the coal shovel to reach loose material and therefore some coal will have to be bypassed until the next cut is uncovered. This makes a ragged pit and may result in some coal being lost under the spoil bank.

Stripping Thick Cover

Where extra thick cover is constantly present, the big dragline is the most popular machine. However, the successful application of the 60-yd shovel shows that the shovels can not be counted out in the thicker cover. Since going into service in February of this year, the 60-yd giant's performance has been very satisfactory. Output has been at a rate well over 2,000,000 cu yd per month while working to 80-ft banks.

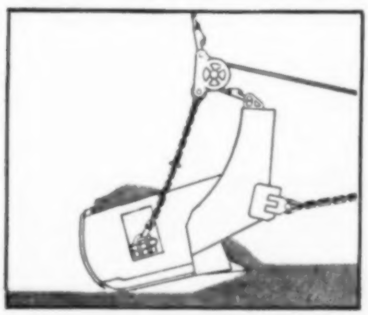
The question of what is the top limit for dipper size has not yet been answered. Already plans are under way to build a 70-yd shovel.

There is no fixed rule regarding equipment application and many combinations of machines are doing yeoman duty. For example, a shovel may be teamed with a dragline in a tandem operation to remove thick cover that could not be handled readily by either alone. In this type of setup, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

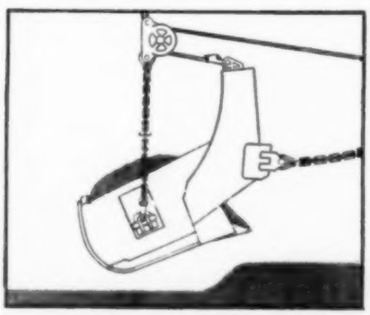
Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. The choice of equipment depends upon the job and the quantity of material to be rehandled. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible

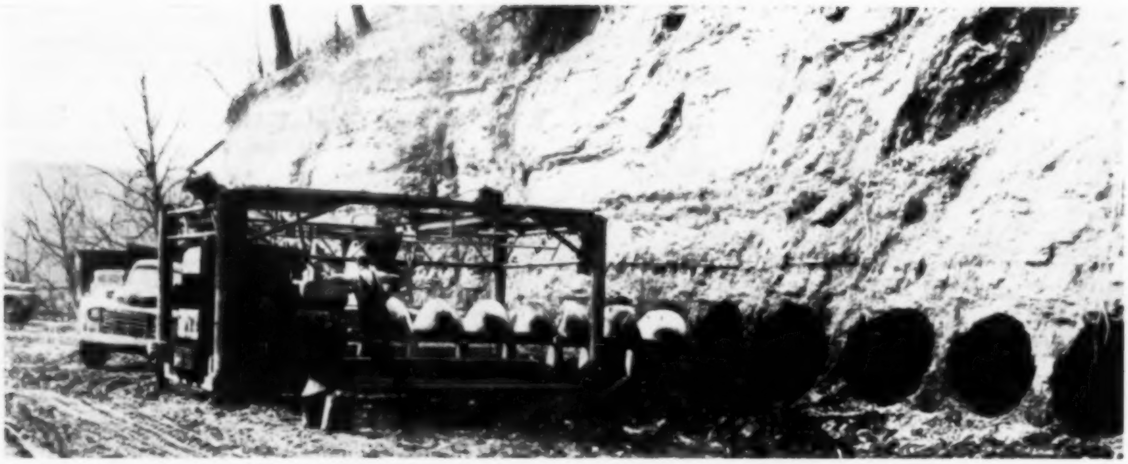
Digs and Fills



FILLING ACTION causes bucket to level off as weight of material shifts center of balance to the rear.



COMPLETELY FILLED, bucket is ready for hoisting. No need to continue dragging and thus waste time.



HIGHWALL AUGERING produces low-cost coal that balances the higher cost of stripping thicker cover. Augers also can be used effectively to recover coal left between abandoned deep mines and outcrop.

for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range or working limit, rehandling materials, or working in two lifts the dragline definitely offers advantages. Since the 60-yd shovel has proven its ability in 80-ft banks, big shovels can not be ruled out in the thicker cover, however.

Whenever possible, thick cover should be removed by casting. However, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged high-powered end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material. In many cases, spoil is hauled to worked out sections of the pit, while in others such as hillside stripping, it is hauled to ravines or below the outcrop. The wheel excavator with its stacker belt also may be classed as a spoil hauler as well as a stripper since it carries spoil beyond the limit of the ordinary stripping unit.

When the overburden is too deep for a single stripping unit or when material is unstable in the highwall or in the spoil pile, the tower rig is worthy of consideration. The tower excavator consists of a head tower, tail tower and a scraper-type crescent bucket. Yardage output of this type of stripper cannot be compared with the high-speed shovel or dragline but the machine does serve the special needs of handling unstable material.

A great deal of preparatory work is needed before the machine can be put in operation. A 90-ft-wide road must be built on the spoil bank for the entire length of the pit and a minimum of six cuts from the operating cut. The head tower then is set up on the spoil and the tail tower on the highwall.

Operating procedure is to take a construction cut on a 15-deg slope upward toward the head tower. After this cut, the tower returns over the same road, taking the highwall as it goes and depositing it as a blanket on the sloped spoil.

The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three objectives in using the machine are: (1) to permit handling overburden up to 85 ft thick, placing the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; and (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

Operating experience with American wheel excavators show that they can move 1,700 cu yd of overburden per hour and spoil it a maximum distance of 388 ft from the digging point (*Coal Age*, March, 1955, p 58). Power costs per yard are the same as a large shovel and are considerably less than draglines.

A significant saving in drilling and blasting cost is possible with the wheel excavator where it can be used. For example, one Illinois operator was able to shorten blastholes by 30 to 40% while eliminating the problems of hole squeezing and casing through sand. At the same time bit cost was reduced considerably.

Two Seam Stripping

In some instances, both in anthracite and bituminous, two seams fairly close together can be mined profitably where one alone would not be a profitable venture. Or, recovery of a thinner second seam, since overburden removal is necessary to get at the main seam anyhow, provides a low-cost additional source of tonnage. The method of mining and equipment used for multiple-seam stripping depends upon the dip and thickness of the beds; the lay of the land, whether gently rolling, flat or hilly; and the type of rock above and between the seams.

In anthracite mining, multiple-seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden can be moved by a specially designed shovel (*Coal Age*, August, 1954, p 64); two draglines plus an auxiliary shovel (*Coal Age*, July, 1955, p 56); or a shovel and dragline (*Coal Age*, January, 1953, p 84). The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel strips

BACKFILLING and leveling can be done at the rate of 600 cu yd per hour with modern bulldozers equipped with turbo-diesel engines.

COMBINATION drill and sweeper performs double service and speeds coal preparation to increase over-all efficiency and conserve manpower.

two seams simultaneously from one position in gently rolling country. Both seams are thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovers a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel are used in a flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks range between 50 to 70 ft in thickness, the two draglines work in tandem, and where cover is thinner they work separately. The limestone interval between the two seams is drilled with percussion units and the broken material is cast to the spoil area by the coal shovel on the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure is to remove the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removes part of the cover and makes a bench on the upper seam for the dragline, which strips to a 40-ft bank. After this coal is removed, augering is done to complete mining in the upper seam. The next step is to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam is the final stage in mining at this property.

Augering

Since the highwall auger was introduced to the industry 7 yr ago, it has grown to the point where it is producing more than 3,000,000 tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

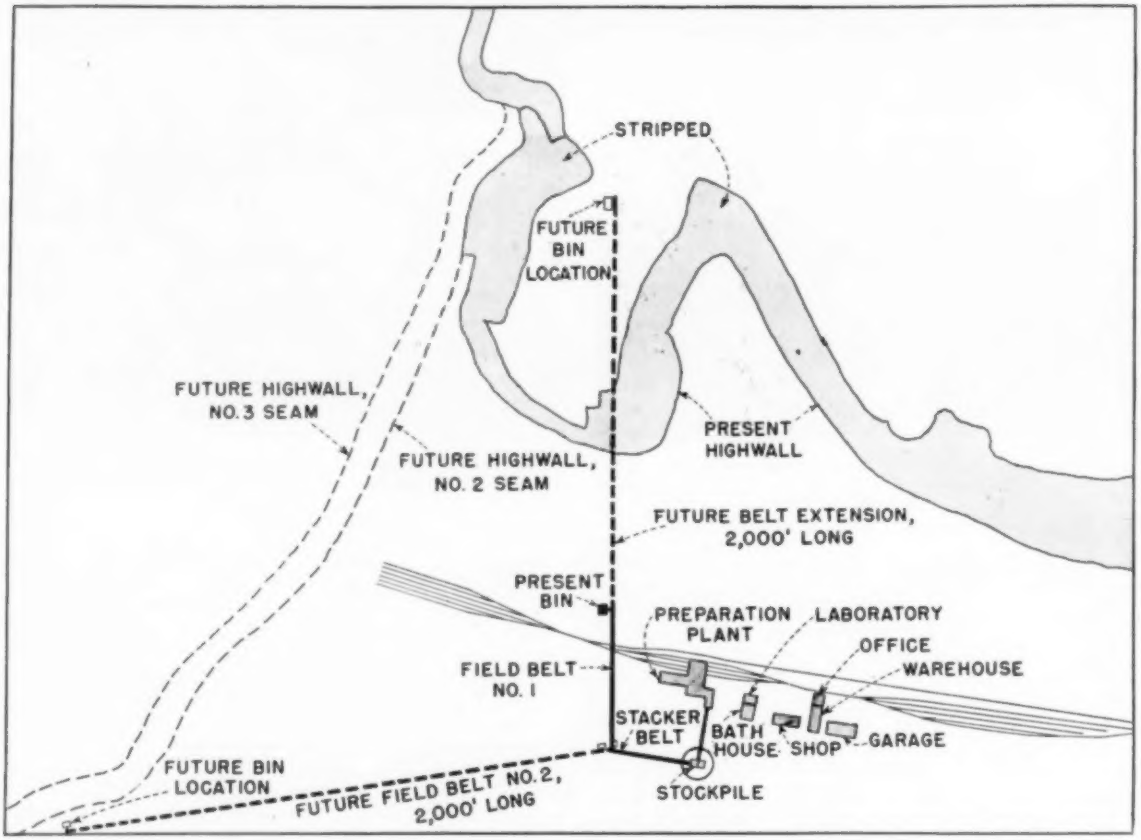
Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam is overlaid by a layer of high-ash coal, selective mining can be practiced and clean coal produced without preparation.

If augering is to be done as part of the stripping operation, it is wise to make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left unshattered and stable. A highwall slide can endanger the lives of men or result in serious damage to the auger in addition to causing a loss in production. A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, and the thickness and the strength of the coal.

Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height. However, for seams more than 5½ to 6 ft thick, it is best to use a smaller auger and double drill, preferably overlapping the bottom hole into the top. Staggering top and bottom holes is another method. The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

Early augers were quite large and required pits up to 90 ft wide. Success of these models led to the development of small ones for use in thinner coal and narrower pits. Today's augers are available in diameters ranging from 16 to 52 in, and are capable of producing as much as 800 tons of coal per shift. To permit greater flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit. A four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be all that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done, a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.



OVERLAND BELT eliminates the cost of building long high-speed haulage roads. Field belts are extended in 2,000-ft units to keep truck haul to a maximum of ¾ mi.

Coal Loading

THE QUESTION of whether coal should be broken with explosives before loading can be answered best by a careful study of the physical properties of the coal, the size of the coal shovel, and the presence or absence of impurities in the seam. Where the coal is of average thickness and hardness, explosives used for breaking overburden usually will loosen the coal sufficiently so it can be loaded easily without blasting. Carefully placed holes in the overburden usually will permit explosives to fracture the coal to whatever degree is necessary to permit easy loading.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are gaining in favor for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is used to sweep the top of the coal before holes are drilled in the coal and is disengaged from the power unit when the combination machine is used for the drilling job. Sometimes a hand-pulled wagon with a gasoline-powered drill is satisfactory.

Still another tool for preparing thin seams for loading is the pinning machine. This unit travels over the coal on crawlers, dropping a weighted, pointed steel pin or pins that pierce the coal and fracture it enough to permit easy loading. The advantage of this machine is that the coal can be broken as quickly as it could be drilled, the cost of explosives is eliminated and a minimum of fines is produced.

Coal Cleaning

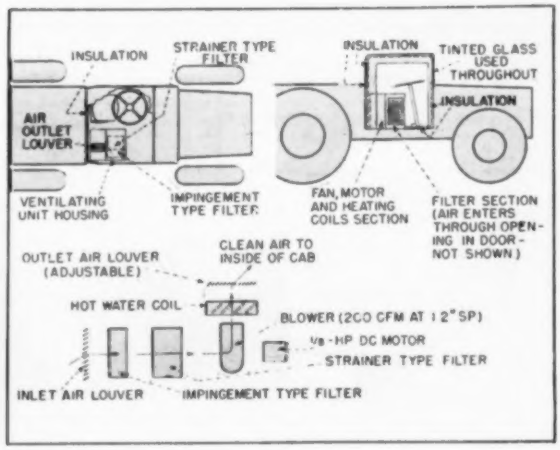
Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

Loading Methods

There are available for the loading job a variety of units with capacities and design features to fit any pit condition. First consideration in choosing a coal-loading machine is to get the right capacity. This means matching loading capacity to the stripping capacity. In some cases it might be desirable to have some excess capacity in the coal shovel in case of hard digging, or transportation or tipple delays that jam up empty trucks at the loading point. By loading trucks rapidly, with an oversize shovel, the haulage cycle can be put back to normal with a minimum of time required. Thus the plant can be fed uniformly without surges.

If the coal seam is thin, it is well to consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom while loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom. In other instances, a conventional shovel equipped with a specially designed dipper is a satisfactory

RAIL HAULAGE with diesel locomotive offers advantages where topography is favorable and ample reserves are available.



VENTILATING UNITS on equipment cabs provide safety and comfort. Air is changed one to five times per minute.

unit for loading thinner seams of coal.

If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading time will be as low as possible on the regular shift. The loading shovel thus can load a truck faster and coal will be carried to the tipple at a faster rate.

Increasing Coal Recovery—The importance of recovering all the coal that is uncovered cannot be overemphasized, particularly where the seam is thin. If by careless operation of the coal-loading shovel 3 in of coal is left on the bottom over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much over-shooting or in too much loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal—with the aid of scarifying arrangements if necessary—and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading. If a washing plant with sufficient capacity is available, some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of it in a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112. To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre (*Coal Age*, November, 1949, p 80).

Transportation

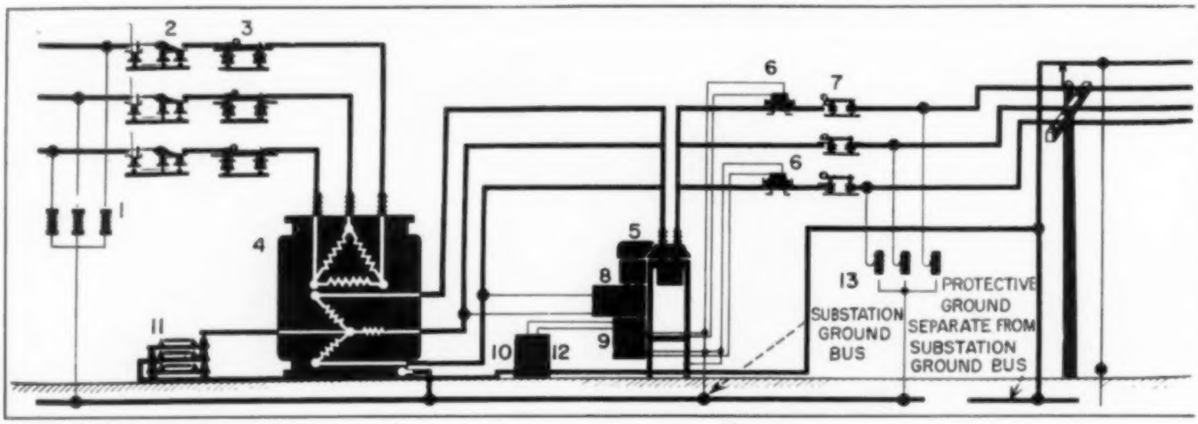
Good haulage today depends upon modern equipment installed and used in a workmanlike manner. The rugged end-dump truck and semi-trailer are the favorites for coal haulage, with the overland belt from pit to preparation plant an added starter in the transportation field. To pick the most suitable equipment or combination of units for the best haulage results, a careful analysis must be made of the job to be done.

The largest available unit does not always mean a lower cost per ton because final truck selection is based on many factors including production, pit width, type of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the size of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

Overall height of the truck should be such that it makes a good target for the loading shovel. Length should be a minimum and width a maximum so that the shovel loading cycle can be kept to a low value. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 70 tons or better with tractor-trailer units in bituminous. Power is supplied by engines up to 400 hp. In the past 5 yr trailer weight has decreased, and payload and speed have increased by 25 to 30%.

Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loaded trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a



Components of an Open-Pit

1 **LIGHTNING ARRESTERS**—for protection against high-voltage surges on the high line.
2 **DISCONNECTING SWITCHES**—for disconnecting substation from high line.
3 **BA FUSES**—for short-circuit protection.
4 **TRANSFORMER**—may be either three single-phase units or a single three-phase unit.
5 **OIL CIRCUIT BREAKER**—for short-circuit and ground-fault protection on distribution lines.
6 **CURRENT TRANSFORMER**—for use with type CO overcurrent phase relays.
7 **DISCONNECTING SWITCHES**—for disconnecting distri-

37-ton truck with a standard transmission on the same route.

Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-v units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start them.

Hydraulic retarders are now available for controlling the speed of trucks on long steep downgrades. The unit also acts as a governor. Mounted on the drive shaft of the truck, the device is designed so that when the shaft speed increases, the retarder resistance automatically increases at a much faster rate. Therefore any tendency of the truck to run away is curbed by the retarder which piles up resistance very rapidly when the truck's speed tends to increase. A control valve by the driver regulates the degree of braking available by controlling the oil passing into the retarding device. Aside from slowing the truck, the device is said to save tires, fuel, time and brake lining.

Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can load a trip of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

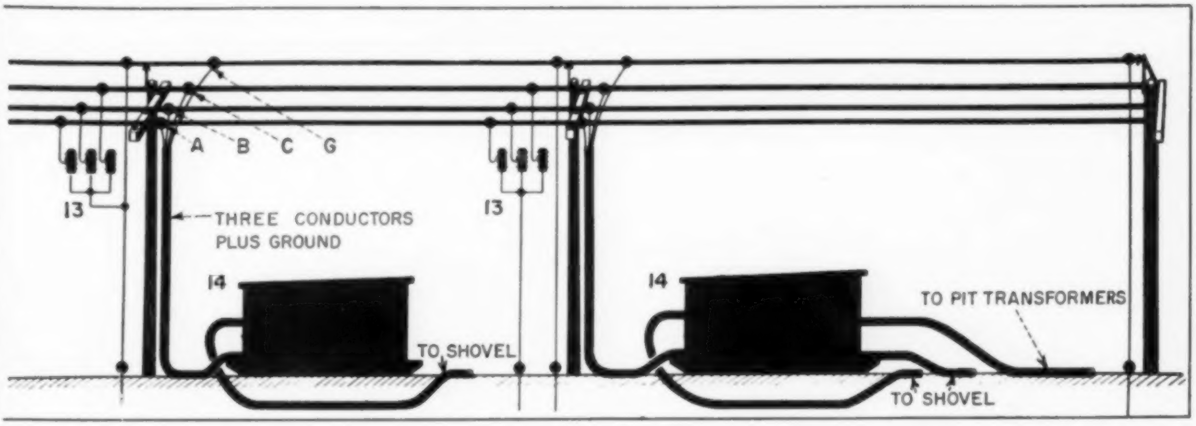
An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age*, August, 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long high-speed haulage roads.
2. Permits movement of larger tonnages with fewer and/or smaller trucks.
3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.
4. Reduces the manpower required for maintenance of trucks.
5. Requires a smaller supply inventory and less garage space.

Road Building

Where haulage is completely on roads, it is of vital importance that a good running surface be provided. Main roads should be built with wide road beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should be superelevated. Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog. One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season not only to maintain good visibility but also to keep dust out of truck engines and moving parts.

Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short, comparatively steep rises. Therefore less clutching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and overspeeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.



Power Distribution System

bution lines from substation.
8 **CAPACITOR TRIP DEVICE**—providing a source of energy for tripping oil circuit breaker.
9 **TYPE CO PHASE RELAYS**—for short-circuit protection.
10 **TYPE CO GROUND RELAY**—for ground-fault protection.
11 **GROUNDING RESISTOR**—for limiting ground-fault current.
12 **CURRENT TRANSFORMER**—for use with type CO ground relay.
13 **LIGHTNING ARRESTERS**—for protection against high-voltage surges on distribution lines.
14 **PORTABLE SWITCHHOUSES**

Entrances to the pit should be one way if possible. Turning and backing large haulage units takes time and thus reduces haulage efficiency.

In winter, roads should be cleared of snow before trucks start to operate. This will prevent formation of slippery conditions caused by compacted snow. A motor grader, started several hours before trucks begin to travel, should be able to clear an average snowfall. If there is a severe storm, bulldozers should be added to help move the snow.

Power

MOST POWER for strip mining is purchased from privately owned public utilities, at voltages ranging from 6,600 to 66,000 volts. Most commonly, the voltage is 33,000 though higher voltages are becoming more frequent. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 volts coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

Primary distribution systems generally fall into two general classes:

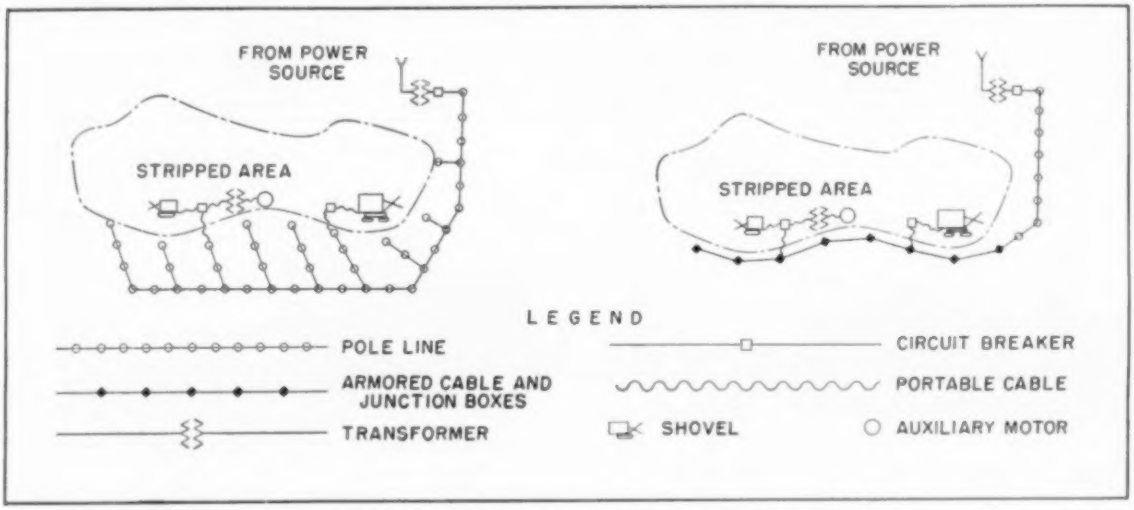
1. Pole-mounted high lines.
2. Cable systems.

A third version is a combination of pole line or lines and cable line or lines. Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

Ground-Cable Systems—A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switchhouses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grounding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.

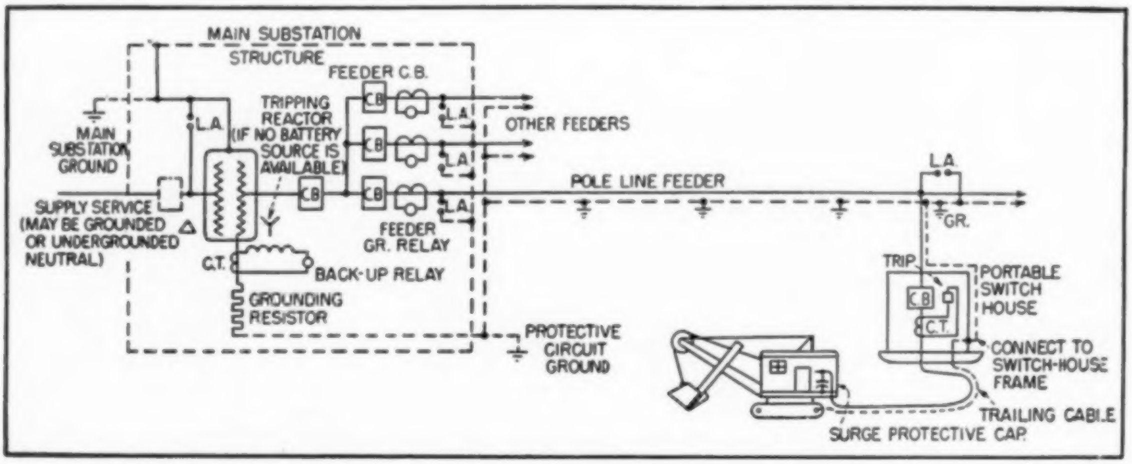
Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

From a previous top of 46 to 50 cu yd, dipper capacity reached a new

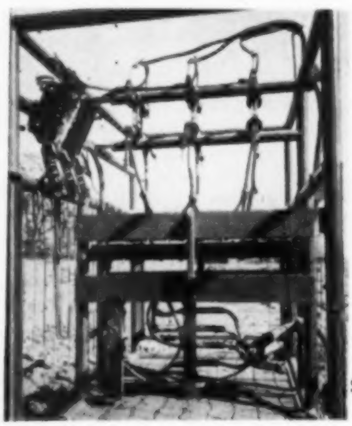


TODAY'S power distribution systems at strip mines include both lateral pole lines and armored cables.

Adequate Power Is a Key Factor in Modern Stripping Operation



POWER-DISTRIBUTION SYSTEM with grounded neutral includes the features needed for protection of men and machines against short circuits and overloads. The circuit is deenergized immediately if a ground fault occurs.



SAFETY and flexibility are features of this cable junction center.

high of 60 cu yd in 1955. At the same time, a new high in connected horsepower, main AC motors, was established, resulting in a decision to break another barrier—operating voltage. Compared to the previous high of 4,160, the new shovel was designed to operate on 7,200 volts. Peak power demand will be 6,840 kw.

Protection — Basic protection includes station-type lightning arresters with, for example, 50-amp fuses on the primary side. On the secondary side, aside from standard breaker and other facilities for overload, etc., standard practice in distribution is Y-connected transformers with ground resistor and current transformer in the ground wire to trip the cable-feed breaker. A newer form of ground trip employs a "doughnut"-type transformer around the three phase wires. Any unbalance resulting from a fault is detected by a special current transformer, which trips the breaker through the usual facilities. Compared to a normal voltage of 2,000 (4,160-v service) between machine frame and ground without facilities of this type, grounding as described normally limits the voltage to 100 during the interval

PLANNED DRAINAGE to handle water at low cost includes strategically located pumps and adequate pipe lines.

PREVENTING INFLOW can be achieved by spanning pits with pipe or flumes.

before the breaker trips to take the machine off the line.

Power Factor—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units. Without correction, power factor would usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

Cable Testing and Fault-Finding—Insulation failures and shorts in high-voltage distribution or service cables in strip pits can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 v and 40 milliamp, or sufficient to test up to 7,500 v. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk the cable. If the fault resistance is very low, dead ground or under water, a pickup coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

Drainage

THE AIM IN DRAINAGE is to handle water at as low cost as possible. Good drainage procedures can pay off in lower material cost and less labor. Also men and equipment will perform better if the working area is kept free of water.

To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor to permit water to flow by gravity to a drainway in the spoil.

Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically, thereby cutting labor costs.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps. However this may not be desirable in weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.

The Preparation Guidebook

BUILDING BUSINESS by making coal more economical, convenient and satisfactory for the user is the goal in preparation. The four major methods of achieving consumer satisfaction are:

1. **Proper size** for the particular application.
2. **Maximum Btu content** per dollar spent by the consumer through elimination of impurities and moisture. Good sizing also plays a part here, too, by making possible more complete combustion and thus more liberation of heat at the point where it can be effective.
3. **A high degree of uniformity** in all characteristics—size, heat content, ash and so on—meaning a product on which the consumer can depend day after day and year after year. Uniformity can be even more important than, for example, maximum impurity removal.
4. **Maximum convenience in use.** For example, should the coal be treated to eliminate dust in handling? Should the coal, if washed, be dried or treated with chemicals to eliminate unloading and handling difficulties in freezing weather?

Designing for the Market

In setting up a preparation plant or system to attain the preceding goals today—and in the foreseeable future—the first job is to ascertain to the maximum degree possible what the market will require in:

1. **Size of product.** For example, the trend still is toward the smaller sizes, and is being accelerated by the growing use of coal by the utilities.
2. **Ash, sulphur, heat and moisture content.**
3. **Dustproofing, freezeproofing** and other convenience factors.

Next, the coal itself must be studied. It may, in its natural state, provide some of the desirable qualities—or in some exceptional cases, all of them. Where it doesn't provide them, can it be treated so that it does? The latter question usually is the critical one. It may be possible to process a certain coal to meet very rigid requirements for ash, but in the processing it may be necessary to reject an excessive percentage of the raw feed. Therefore, when all the pros and cons are weighed, a greater realization may be secured by a higher ash and a higher recovery with a high degree of uniformity. In the last analysis, in fact, the test is economic, meaning a balancing of realization, plus the promotion value of being able to offer a processed product, against the cost—in equipment, in labor or in loss of raw feed—of achieving certain specifications.

Designing for Low Operating Cost

Actual cost of the preparation operation also is a question meriting the most careful study. Operating labor, including labor for such things as hand picking, is a critical factor. Operation with not over 4 or 5 men is fairly common today, and the goal should be as few as possible.

Maintenance also is critical. Proper design and the use of modern materials is the best way of preventing the spectacle of a maintenance crew as large or larger than the operating crew taking over at the end of a day of plant operation. Then there is the question of changes and plant additions—which are a normal part of the conduct of a plant operation. Proper design speeds these changes by providing working space and places to put the new units that changes in the market indicate will be necessary in the future though not required when the plant was first built.

Raw-Coal Storage

PURPOSES:

1. Preventing interruptions in mine operation from shutting down the preparation plant and vice versa.

2. Providing some degree of blending of the raw feed to the plant.

3. Providing a means of evening out the flow of coal to the preparation facilities, thus permitting washing equipment, for example, to do a better job.

Capacity

Even where raw-coal storage facilities are underground, the prevailing practice is to provide at least ½ hr of the rated capacity of the mine or plant, with 15 min as about the minimum for anything more than a hopper to hold a car or two. From 15 min to ½ hr also seems to be the rule at most strip-mining operations receiving coal from trucks.

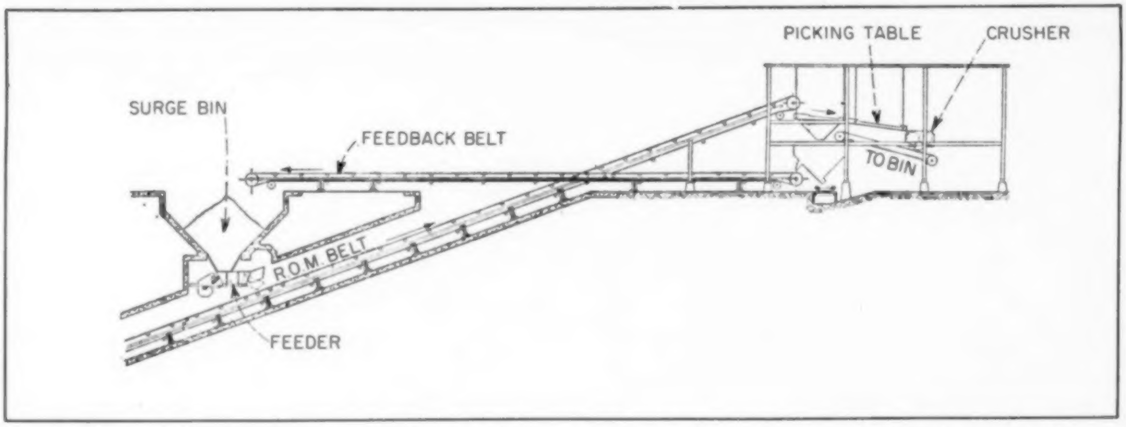
A trend toward even larger storage capacity seems in evidence, however. Examples include the following:

Deep mine, outside bin mounted on structural members under a dump bridge and receiving coal from drop-bottom cars, 2,500 tons of capacity for a plant rating of 700 tph.

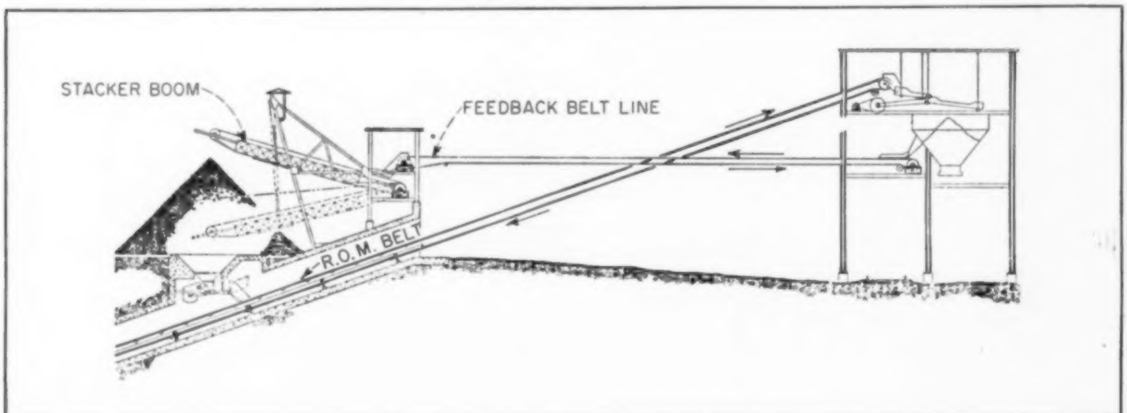
Deep mine, 5-compartment silo mounted on hill above plant, 2,200 tons for a plant capacity of 600 tph.

Deep mine, single concrete silo, approximately ½ day.

Where ground storage is provided, capacities up to 2



RETURN VIA SLOPE BELT is a feature of this ground-storage plan using a feedback conveyor to place the coal in a hopper. Storage with this system is limited by the size of the hopper or surge bin.



INCREASED CAPACITY in ground storage over slope belt is provided by stacker boom. Raising end of feedback belt and using a bulldozer or dragline for reclaiming is another method of increasing capacity.

or 3 days are provided in some instances, as follows:

Deep mine, bin over slope belt with feedback belt from preparation plant, 10,000 tons, including ground area around bin.

Deep mine, ground storage with feedback belt over glory hole back to slope belt, approximately 1 day.

Strip mine, ground storage at preparation plant, several hours' capacity, conventional reclamation equipment.

Underground Storage

Capacity of one hopper feeding a slope belt at a plant rated at 500 tph is 260 tons. The hopper is 16 ft wide and 66 ft long. Maximum depth is 18½ ft. Designed to receive coal from a belt system, this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom section permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

The dumping characteristics of dropbottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example, 96.7 tons in a bin 40x12 ft by 10 ft deep.

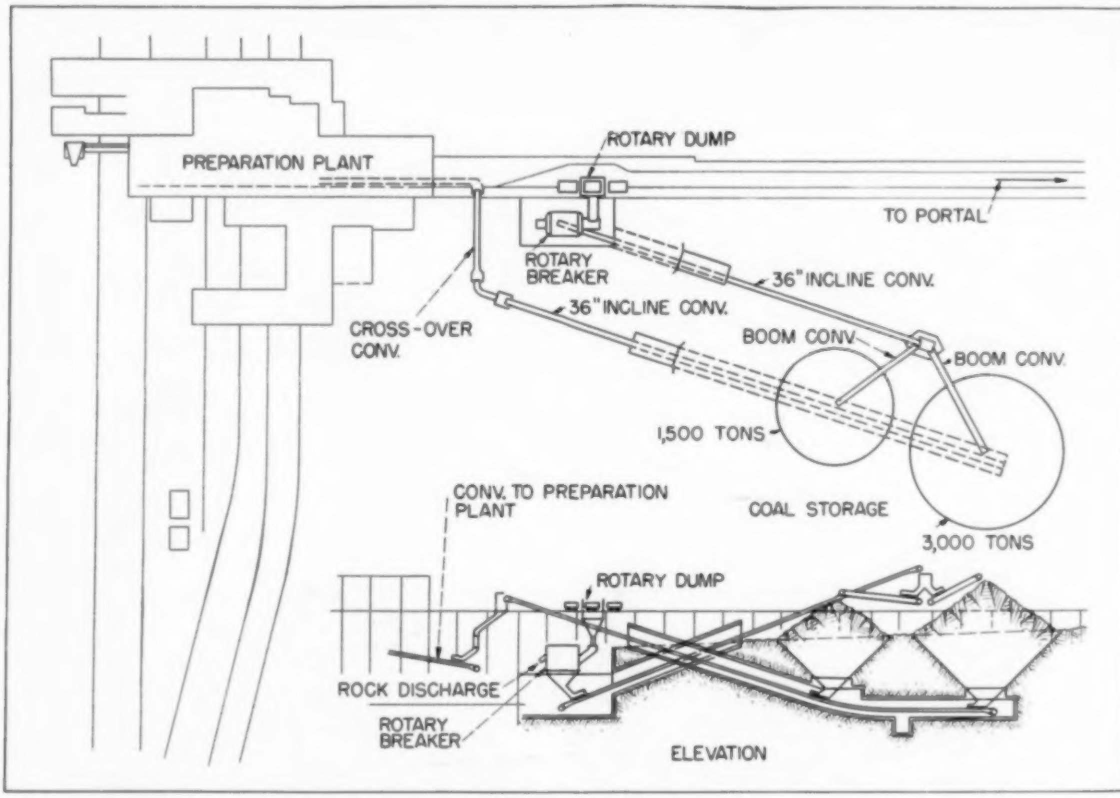
Size of underground hoppers occasionally reaches as much as 2,000 tons. Usually, hoppers of this size are employed where there are two seams close enough together so that the hopper can be excavated in the interval to receive coal from dropbottom cars. A recent 2,000-ton hopper, for example, was placed in an interval of 105 ft between two seams and holds all the record-shift production from the main seam, feeding to a reclaiming conveyor which in turn discharges to the main slope conveyor (*Coal Age*, June, 1955, p 60).

Separate smaller rock bins next to the main bin for direct dumping or so located that a flygate can divert rock into them are employed where it is desired to keep coal and rock separate. Normally, dumping is by mine cars, but even hoppers designed to receive coal from belts can be arranged in this fashion provided rock loading onto the belt is sufficiently segregated from the coal.

Surface Storage

Although some form of bin or hopper still is the most popular form of surface storage of raw coal, there is, as previously noted, a trend toward open or ground storage. Where space is available for ground storage, the quantity that can be stored can be greatly increased with a minimum of investment. In other words, the cost of bins or hoppers is eliminated, but part of this saving normally is offset by the fact that some type or types of stocking and reclaiming equipment is necessary, even for relatively small tonnages.

Two examples of surface storage designed to permit



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits by boom conveyors, and reclamation by feeders to subway conveyor. Storage and reclamation is either automatic or remotely controlled.

return of the coal via the main slope belt are shown in the accompanying illustrations. In one, capacity is 200 tons in the form of a glory hole. However, if the discharge end of the recirculation belt was elevated and a bulldozer or dragline was added, as in certain other installations, capacity could be raised to 10,000 tons or more. In the second design, additional capacity is attained by using a hinged stacker belt. Here, too, capacity may be increased by lengthening the stacker belt and adding a bulldozer, dragline or other reclaiming unit.

Reclamation by subway conveyor is provided for in the recent plan for surface storage shown in another accompanying illustration. From the rotary dump, the coal goes to a rotary breaker for size reduction and removal of hard, heavy rock. It then goes onto an inclined conveyor feeding a distributor hopper. From this elevated hopper, boom conveyors put the coal into either of two conical storage piles. The flygate switching coal from one boom conveyor to another is remotely controlled, and electrodes are installed on the ends of the boom conveyors to raise them automatically when the coal level reaches them. One of the funnel-shaped storage pits has a capacity of 3,000 tons; the other, 1,500 tons. Feeders under the pits put the coal on the reclaiming conveyor. A more uniform raw feed to the plant, with better final quality, is one of the expected advantages of the installation.

Ground storage may be accomplished by dumping from trucks in a flat pile with bulldozer spreading. Reclamation may be by standard shovel and trucks or by tractor-mounted shovels. Another method of stocking is to use a conveyor with an elevated end, receiving coal from trucks, headhouse or tipple. Piling the coal high in conical shape reduces to some extent the ground area required. Pivoting the conveyor to permit continuous stocking in an arc increases capacity per square foot of ground area. And where trucks are employed, a variation applicable to hilly country is to excavate a bench in the hill, with trucks dumping over the back wall and conventional equipment picking up the coal as desired from the bench.

Storage of large quantities of coal in piles or elsewhere requires checking against the possibility of spontaneous combustion.

The conventional square or rectangular bin—steel, concrete or timber—still is the most-used method of providing raw-coal storage where open or ground storage is not employed. Two old hopper cars, one on top of the other, have been used in some instances. However, the round, or silo-type, unit is being increasingly installed. The silo may be built by conventional concrete-pouring methods or may be constructed of regular plate or prefabricated steel sections, or of precast concrete staves bound with steel hoops. A silo 24 ft in diameter and 55 ft high will hold up to 600 tons of coal.

Compartmented or multisilo bins are employed at a number of mines for greater flexibility in storage and also to provide some degree of blending of the raw product. Distribution to a side-by-side or four-cornered multiple unit may be by chutes and flygates. Indicators and remote-controls permit operation of gates and proper distribution without having a man at the bin.

Distribution to long multi-compartment bins may be handled by a distribution belt with tripper. Other methods

include a wheel-mounted shuttle belt similar to that employed in loading railroad cars which is moved back and forth to place the coal in the proper compartments. Or a scraper conveyor with fixed openings or movable gates may be used.

In deep bins, degradation may be reduced by installing spiral or ladder-type lowering conveyors.

A growing practice reflecting, among other things, the growth in full-seam mining, is combining rough cleaning and preliminary crushing (if practiced) with surface storage of raw coal to conserve labor, improve plant maintenance and raise plant efficiency, as in one of the storage plans summarized previously in this section.

Raw-Coal Blending

PURPOSES:

1. Assuring maximum uniformity in the characteristics of the coal fed to cleaning units and thus in turn, assuring a better final product by enabling the units to do a better job. Uniformity of characteristics in the final product is especially important in metallurgical coal, and the majority of blending plants to date are at metallurgical mines.

2. Providing storage capacity and evening out the rate of flow to cleaning units, thus helping to promote uniformity and quality in the final product in another way.

Since the usual goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more. The more the compartments, within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each compartment, the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining—and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose, and permit changes in individual feeding rates to compensate for changes in needs or conditions.

Normally, the coal is placed in the blending plant after preliminary cleaning and crushing.

A less-common type of blending is getting the desired mixture of coal from, say, two different seams. This requires a bin or set of bins for each, which may be filled in any of the usual ways, including dumping directly from mine cars or from railroad cars at a central or "milling-in-transit" plant.

Preliminary Breaking

PURPOSES:

1. To reduce all oversize material in the raw feed to a certain top size, say 6 in, usually done where the market for lump is considered too small to warrant preparing this size or where the coal is destined for, say, metallurgical use.

2. To reduce extra-large lumps without especially attempting to get everything to a certain top size. Convenience and smoothing out the flow of coal through the plant are the major objectives in such breaking. Freeing bone or partings from coal to facilitate picking or cleaning is another objective in some instances.

Preliminary breaking and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case—a scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. Roll diameter, tooth design, tooth positioning and speed are major factors, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher proportion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

In anthracite particularly, stage crushing has been the practice for many years because of the nature of the raw product and also the size list produced. In anthracite it sometimes happens that the rock exceeds the coal in the raw feed and therefore picking sometimes is set up to remove coal from the rock rather than vice versa. Whatever the system, however, after scalping out the fines, the coarse coal goes through the first rolls, after which the process of scalping and additional breaking of the large material may be repeated a second and even a third time.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Crushers normally are built to handle iron, particularly if it is not too large. However, the better practice is to keep it out not only of crushers but of the entire plant circuit. If possible, therefore, magnetic removal equipment should be installed ahead of raw-coal crushers; if not possible, at some logical point following crushing, or ahead of the raw-coal screen if preliminary breaking is not the practice. Iron removal is considered a good practice even where washers are employed, since it reduces the possibility of plugging and damage to equipment up to and including the washers.

Rough Cleaning

PURPOSE: Quick removal of coarse rock and other impurities to reduce the burden on subsequent preparation units and also to permit higher efficiency in the removal process itself.

The major rough-cleaning methods are as follows:

1. Use of a picking table receiving all the mine-run product.

2. Use of a scalping screen followed by a picking table. This is a perferred system, since it removes the fines and thus facilitates picking, which may be either rough with the idea that final impurity removal will take place in mechanical cleaners, or may be final where the coarse coal is to be loaded without any further treatment.

3. Use of a rotary screen-type breaker, which accomplishes both a reduction to a certain top size, depending upon the size of perforation, and rejects the hard rock—or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. Use of roughing cleaners to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be by-passed around the roughing

unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Rough cleaning by hand frequently precedes breaking, as noted in the previous section, and has the advantage, among others, of reducing the load on the breaking unit and reducing the output of fine sizes in the breaking operation by getting the hard, heavy rock out of the way.

Separate headhouses or roughing plants are being increasingly employed for preliminary breaking, rough cleaning, mine-rock disposal and raw-coal screening. This is a natural development at hillside mines, but the same practice can be followed at slope and shaft operations. With separate plants, it is easier to put the necessary heavy equipment closer to ground level, reducing structure cost and maintenance. Also, a prime source of dust, noise and vibration is removed from the main plant.

Raw-Coal Sizing

PURPOSE: Separation of the feed into the necessary fractions to permit picking, cleaning and other operations on the various fractions. In plants preparing by hand picking and cleaning, the raw-coal screen may also make the final sizes to be loaded.

The shaker screen, inclined at approximately 15 deg and with a crank or eccentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening, where one shaking unit, with decks and extensions as necessary, can size the coal, provide facilities for picking, and distribute a number of sizes to their respective loading booms and chutes. If the unit is inclined at the usual angle, lengthening it out requires more headroom. This, among other reasons, resulted in the development of the level shaker with differential-motion drive to move the coal along the unit.

A second difference between the two types of screens is the fact that the vibrating type though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type or coat, type of screen and method of operation.

The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose. Laminated-plastic hangers are now used on such screens instead of boards (*Coal Age*, September 1955, p. 67). Advantages include longer life, no change in length and better screen action.

With the growing trend toward mechanical cleaning, the raw-coal sizing screen is more and more being called upon for a rather simple separation of the raw feed into two or three fractions. Where this is the situation, the shaker can be a rather short machine. This situation has favored the rise of the vibrator in raw-coal screening also. Even where only a certain fraction of the coal is mechanically cleaned—screenings, for example—or only a certain size or sizes are treated—nut and pea, for example—the simple two- or three-product shaker may be employed with further raw-coal sizing allocated to vibrating screens. This, in fact, is a growing practice at bituminous plants, even where everything, or everything up to, say, 6 in, is mechanically cleaned, particularly if the plant is designed for treating several size fractions in different cleaning units.

Screening Factors

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings, depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time on the screen also is a factor, though the opportunities for increasing it are somewhat limited and where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On shakers, types of plate used to reduce wear include cast manganese.

Hand Picking

PURPOSES:

1. **Impurity removal.**
2. **Improvement of appearance.**
3. **Production of a separate fuel grade.**

From the standpoint of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking may also be employed to improve appearance by removing off-standard material. In addition coal cleaned mechanically or otherwise may be picked before loading to remove wood chips, stained pieces and the like. Here, the operator must balance any gain in realization resulting from improved appearance against the cost of such picking, which is high.

Where bony by itself or in combination with good coal is fairly high in percentage, some operators use picking as a means of removing this material, which then is crushed and sold as a power-plant fuel.

Under reasonably good conditions, and where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph. This relatively low production at rather high cost is in part responsible for the trend toward crushing everything to, say, 6 in, and conversely toward raising the top size mechanically cleaned up to 6 to 8 in, and more recently up to 12 to 14 in.

Hand picking can result in a substantial loss of coal values unless provision is made for treating the pickings. The usual practice is to crush the pickings and run them to mechanical cleaners if used.

Picking Equipment

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special condi-

tions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards over the rollers or along the edges and thus necessitate lifting each piece to remove it.

The flat table may be a part of the shaking screen or may be separate. When separate, the table normally is sloped at about 5 deg and is operated at 150 to 160 rpm, 4- to 5-in stroke, crank or eccentric drive. Platform tables used in anthracite have a pitch of ½ to ¾ in in 12, with a 2-in stroke, 370 to 400 strokes per minute. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side, where the motion of the table carries the impurities to the discharge opening. Refuse chutes should be equipped with bars to prevent passage of pieces large enough to block the refuse conveyor.

In addition to elimination of lifting, factors contributing substantially to the efficiency of the picking operation include the following:

1. Depth of bed not exceeding the size of one piece.
2. Even flow with a speed of travel not over 80 fpm, and preferably between 30 and 60 fpm.
3. A width so that a man does not have to reach more than 30 in from the edge.
4. Height of approximately 32 in above the place where the man stands.
5. Spacing of at least 4½ ft between pickers, including the refuse chute.
6. Chute tops flush with table top and equipped with backboards to make it unnecessary for the picker to take his eyes off the table and permit him to use both hands.

Washing

WASHING is a form of mechanical impurity-removal, or cleaning. Mechanical cleaning is growing because it has these definite advantages:

1. Mechanical cleaning is the only form of cleaning providing effective results on the finer sizes of coal.
2. A mechanical cleaner, properly adjusted and within the limits of its characteristics, provides the maximum in product uniformity—a major factor in market acceptance of the product.
3. Mechanical cleaning cuts labor costs per ton to the minimum and thus, compared to hand picking—at least in certain sizes—can sometimes reduce over-all preparation cost for a real cleaning job substantially.

What actually happens in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium. In the main, however, separation is accomplished as a result of the difference in specific gravities of the coal and impurities in combination with the buoyant effect of the separating medium. In other words, where buoyance or its equivalent is present, the heavier particle will sink and the lighter will float, or the heavier will sink faster than the lighter particle.

The intensity of the buoyant force is expressed in terms of specific gravity. A high specific gravity means that a given separating medium will float a heavier particle. In other words, it is more buoyant. Starting with water, for example, specific gravity may be increased by adding a chemical to convert it into a solution, such as, the zinc chloride solution used in float-and-sink tests.

The majority of the coal to date, however, is cleaned by imparting an effect of higher gravity to water by setting it in motion—in other words, artificial gravity. The motion may be up and down, or jigging; continuous upward flow, as in classifier or upward-current washers; or stream, as in trough or launder washers. The goal in all is stratification of the raw coal with the heavy material, or impurities, on the bottom so that it may be split out by various methods. In addition to stream flow, motion may be used to facilitate stratification and separation, as on the coal-washing table. Air is substituted for water in pneumatic cleaners.

True or artificial solutions, however, are increasing in use as separating media. The processes employing them are known by such terms as heavy media, dense media, heavy density, and so on. An example of the true solution used for some years is calcium chloride, normally accompanied by a slight upward current. For the most part, the effect of solutions is obtained by suspending sand or magnetite in water. Mediums derived from the natural refuse also have been used, and a new entry of this type is rock picked out of the coal and reduced to 4x325M in an impact pulverizer. Approximately two-thirds of the pulverized medium is minus 28M.

Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased—an added advantage where the separation problem is difficult.

A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those in "Evaluating Preparation Results," *Coal Age*, April, 1950, p 80.

In the main, however, if the washer is properly selected, is kept in adjustment, and is properly operated (see suggestions later in this section) it will provide the requisite separating efficiency. Basic in selection is detailed knowledge of the characteristics of the constituents of the feed. First of all the sample must be representative of what the washer will be called upon to handle. Then screening, sink-and-float testing, and construction of washability curves will show what can be accomplished under what might be called ideal conditions. Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizeable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June, 1952, p 98.

Washing Practice

Factors in the application and operation of washing equipment include the following:

Size Spread in Feed—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

Even where the washer is designed to take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. In other words, somewhere along the line, the separation efficiency is less sharp—perhaps at the fine-coal end and perhaps at the coarse, depending upon washer design and adjustment. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

By-Passing Fines—Fine coal, say ¼ in or less, may be by-passed around washing equipment for several reasons: (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other units or other types of equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

Uniform Feed—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechanical feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously in this Preparation Guidebook. Overloading should be guarded against particularly. While many washing units have a fair margin of excess capacity, overloading to any considerable extent is almost inevitably followed by a sharp decline in cleaning efficiency and in uniformity of product.

Feed Conditioning—Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer, and consequently is finding increased use. Conditioning also is mechanical in nature. The feed, for example, should be uniform across the width of the washing area. Also, under certain conditions, particularly if prewetting is not employed, provision should be made for getting the feed quickly into the bath and to prevent clotting or travel enmasse, increasing the difficulty of separation.

Media Conditioning—Reclamation and treatment of the media used in heavy-media systems is necessary for at least two reasons: recovery of an expensive material that otherwise would be lost, and preservation of the proper gravity of the bath in the cleaning unit. Media include magnetite, sand, calcium chloride and, in a few new installations, natural or pulverized refuse.

With magnetite, the simplest system consists of a magnetic separator to reclaim the material, previously magnetized to permit this to be done, from the water from the rinse and drain screens. This recovered material then is demagnetized and sent on to a thickener or densifier, from which it is returned to the separator bath.

Variations include use of thickener with overflow back to the rinse and drain screens for part of the water, and underflow to a magnetic separator discharging reclaimed medium to a densifier. Tailings go to a second magnetic separator, also receiving part of the rinse and drain water, with reclaimed magnetite to the densifier and tailings to waste.

Each of several heavy-medium separators in another plant is provided with two magnetic separators which return a concentrate of 2.2 sp gr and about 95% magnetic content directly to the medium circuit without further treatment. Tailings from all separators flow to a desliming sump. The underflow from the sump goes to two 12-in cyclones. Cyclone overflow is used as rinse water, while the underflow is reprocessed in two of the magnetic separators.

Automatic control of bath density is provided for in equipment employed with certain new heavy-media cleaning units. At one installation (*Coal Age*, October, 1955, p 63), rinsing is done only on the lower sections of the drain and rinse screens, thus yielding heavy and dilute medium solutions, the former going to the recirculating sump and the latter to a magnetic separator delivering reclaimed medium to the same sump. Adjustment of the density of the medium is performed by automatically adding water as required to the medium returned to the recirculating sump. At another plant (*Coal Age*, May, 1956, p 69) the reclamation circuit involves magnetic separator, cyclones and a thickener immediately above the coal-cleaning equipment. Automatic valves release medium from the thickener as necessary to keep the gravity of the bath at the desired figure.

Another form of conditioning is removing coal fines from the sand used in sand-flotation cones. The goal is continuous desilting, which is accomplished in one new installation by flowing the sand and water to a German-developed radial screen. The material is fed onto the sloping screens by four revolving arms, and as it flows across the screens is washed with fresh spray water. The oversize, or silt, flows by gravity to the silt sump, while the undersize, or sand and water mixture, is pumped back to the sand circuit.

Proper Adjustment—Maximum washing efficiency does not come automatically with the installation of the equipment. Consequently adjustment is a necessity—and it is necessary to keep a constant check on performance and readjust from time to time as changes warrant.

Fine Coal Washing

Since mechanical cleaning of the finer sizes, say ¼ in or smaller, presents added difficulties and brings in different factors, special equipment is being increasingly employed for this purpose, although, with proper modification, conventional equipment can be and is used for fine coal. The special equipment includes tables (some designed, however, for top sizes up to 1¼ or 1½ in), upward-current classifiers (also offered for larger sizes), and launders of the free-discharge type.

Other equipment applied to fine-coal cleaning on occasions includes centrifuges and cyclones. Thus, for example, if clay particles or other impurities are concentrated in the lower size range, say 48M, they, plus also the coal in this range, may be spun or centrifuged out through the screen or the cyclone orifice. If the coal loss is not excessive, good results may be attained with certain types of coal.

Froth Flotation

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other

washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals by adding a reagent to water and then inducing the formation of bubbles. Refuse particles will not stick to the bubbles but coal particles will and are carried to the top of the bath and removed for subsequent dewatering, or other treatment, and loading or mixing.

Facilities involved in flotation normally include a thickener or hydraulic classifier to size the feed, remove oversize, and so on; reagent feeders and conditioners where the reagent and the coal pulp are mixed and "conditioned"; and the flotation units themselves. The flowsheet also may be modified to include, for example, roughing cells preceding the final treating cells, retreatment units for a coal or primary tailing product from the primary bank of cells, or other modifications.

Desliming

Since leaving the extremely small sizes in the raw feed frequently reduces efficiency in cleaning the fine sizes of coal, the trend today is to deslime or desilt prior to cleaning. Desliming or desilting equipment includes cyclones, hydraulic classifiers, hydroseparators and bowl-type desilters. The latter, as installed at one new plant, consist of a flat-bottom thickener tank with revolving plows to move the settled solids out to the periphery, where they are discharged to a standard rake classifier through a segment cut out of the bottom of the thickener tank. For a summary of how this equipment is employed, see "Thickening and Desliming," p 109.

Desliming with other types of equipment include the following examples:

Classifier desliming silt prior to tabling and flotation (*Coal Age*, May, 1955, p 78). Classifier size is 65 ft, and it is designed to handle 7,400 gpm of water carrying 188 tons of solids per hour. It removes 39 tons of minus 200M slimes per hour.

Hydroseparator removing minus 200M fines from No. 5 buckwheat feed to flotation plant (*Coal Age*, November, 1954, p 96). The hydroseparator is followed by a classifying conditioner using a conical section and baffle plate to concentrate high-ash fines, which are removed by an air lift. An upward-current washer for No. 4 in the same plant is preceded by a spiral classifier, the underflow from this unit going to the flotation plant. The plant also features launder screens for preliminary sizing and conditioning.

Air Cleaning

THE BASIS OF CLEANING with air is substantially the same as for cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in impurity content as possible. Moisture variations are particularly troublesome in air-cleaner operation, in addition to the effect—usually less severe—of high surface moistures.

Present practice in eliminating the effects of high moisture and lack of uniformity in table feed is to pre-dry, and a number of plants recently built include pre-drying equipment of the heat type. At the same time, if total moisture in the mine product normally is high, the operator gains the sales advantage of a minimum moisture content in the shipped product. Increased moisture in the raw product, incidentally, reflects the growing use of water at the face.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is in part the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by pre-drying as previously noted. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal for air-cleaning efficiency.

Since air-cleaning equipment normally is highly sensitive, care must be devoted to adjustment both in installation and in operation. Air supply and distribution are the major factors. Continuous observation of the products is recommended.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The goal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

Dust Collection

Every air-cleaning plant should be provided with an adequate and efficient dust-collecting system—not only for better operation but to prevent the emission of large volumes of dust into the air. Equipment for dust collection includes the following:

1. Large expansion chambers into which the dust-laden air is routed to permit settlement. However, such chambers can trap only the larger particles. Smaller baffled units are employed, however, for scalping ahead of other equipment such as cloth collectors.

2. Cyclone collectors. These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

3. Turbo-centrifugal collectors. Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

Even at 98% separating efficiency, the quantity of very fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of this remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device. To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the

air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Disposing of the dust requires care to see that it is not again dispersed when it is being dumped. One method is to run it into a final wet-type unit to convert it into a paste or slurry. Acid, abrasion and the like are factors to be considered in the operation of cloth-type filters, and require special cloths and other measures to get normal life.

Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water, particularly in the tumbler and hydrostatic units, where the dust-laden air is passed through a water bath. Both units have no moving parts.

Various types of dust-collecting units may be used alone or in combination—for example, cyclones followed by cloth collectors or wet units.

Retreatment

PURPOSE: Increase the ability of the washer to do a sharp separating job by relieving it of part of the load, particularly where the percentage of near-gravity material is high and consequently the cleaning problem is more difficult.

Steps in the retreatment of coarse coal are as follows, starting with a product from the primary washer draw or a special middlings draw:

1. Preliminary screening of the product at 2 in or other limit.
2. Crushing of the oversize to the screening limit to release the impurities.
3. Recirculation of the crushed product to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be recirculated or retreated in a separate unit. This is particularly true in air-cleaning coal under approximately ½ in.

The value of this method of enhancing cleaning efficiency and reducing coal loss is evidenced by the increasing use of separators designed to produce three products: clean coal, middlings and refuse. This has been particularly evident in cleaners of the heavy-media type.

Salvage

PURPOSES:

Reclamation of coal that otherwise would be lost because it never gets to the preparation plant, or because the preparation system is set up to reject it without an opportunity to get it back.

Recovery of coal from primary washer rejects left in because of a desire to get sharper separation or because of washer overloading resulting from a change in coal and refuse character or the need for more tonnage.

Examples of salvage operations include the following:

1. Crushing and washing of pickings, either in regular or special units, to save coal values.
2. Picking out, crushing and loading separately for steam coal a bony product that might otherwise go to refuse.
3. Processing of roof brushings, track cleanings and the like to recover a regular or a steam-coal product. As an example, one plant producing metallurgical coal set up facilities for treating top brushing, which included a rider seam, the product being used for steam raising. Normally, the production of such material should be sizable to warrant separate facilities.

Recovery from primary washer reject also follows, as a rule, the standards of preliminary screening to take out fines and crushing to release interbedded material, although the reject may be treated as it comes from the primary units. The latter, however, usually is less efficient and does not give as good a recovery.

Another form of salvage, widely practiced in anthracite and to a limited extent in bituminous, is reworking contents of old refuse banks and silt ponds or dumps.

Salvage operations ordinarily are carried on with conventional screening, crushing and cleaning equipment. Exceptions include the use of rock-type screens and crushers, and extra-large draws on cleaners where mine material or pickings containing large percentages of rock are processed. One highly desirable characteristic of a salvage cleaner is ability to handle a wide range of feed, both in refuse content and in quantity, since there is less opportunity for stability in either role or characteristics in the average salvage work.

Clean-Coal Sizing

PURPOSE: Separation of the product of cleaning or other processing operations into the final or semi-final size group for loading, or for loading plus additional treatment of a certain size fraction. This treatment may include rescreening, crushing and rescreening, and so on, plus mixing and blending, discussed in later sections of this Guidebook.

Clean-coal sizing, or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing. Certain factors involved in clean-coal sizing are substantially similar to those in raw-coal sizing. In addition, accuracy becomes vital, not only because of its effect on the buyer but also because inaccuracy can materially affect realization by putting larger sizes into smaller. This in turn brings in questions of plate and cloth wear, blinding, and so on. Also, screening should be done to keep degradation in the process to a minimum.

Accuracy Factors

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Time on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though, as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage. Of course, other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided.

Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen over the slack section.

The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

Screen Wear

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings in a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. However, as a general rule, stainless life must be 10 times plain-steel life to justify its use for wear-resistance alone, and therefore bronze or other alloys are favored for heavy plate. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Peristertread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens for the same purposes.

Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening normally increases the size of the through product. In other words, it enlarges the effective opening.

A special form of screen is the lip type, usually with a greater width at the lower end. It provides a tumbling effect and this, together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants, this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, overloading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Excessive flats may be considered a detriment in coal for domestic use. Anthracite is confronted more with this problem than bituminous. Flats may be picked out by hand or, where the quantity is large, mechanical pickers may be employed. These may consist of angles with a gradually increasing opening from feed to discharge end; small-diameter motor-driven rolls (several side by side); and special punched plate with narrow slots into which flats will slide but not the normal lumps.

Blinding—Cause and Elimination

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also can cause major blinding difficulties, especially after the screen has been idle for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. Alloy metals which resist wetting and film buildup.
2. Use of plate, wire and cloth impervious to or less subject to rusting and corrosion.
3. Use of large openings, though this brings in the risk of throwing more oversize into the through product.
4. More screen area or a lower feeding rate with higher moisture.

More fundamental, perhaps, are mixing and blending to achieve uniform surface moisture or predrying of moist or wet material.

Screen Heating—Heating cloth electrically is rapidly growing as a means of preventing blinding. Most screen manufacturers are now in position to offer designs applicable to practically all types of screens. In addition to eliminating blinding and its attendant effects, including the necessity of increasing screen opening, heating also offers two other advantages:

1. Increased screen output—up to 50% or more.
2. Longer screen life—up to 4 or 5 times in some instances. Also, some operators have found that they can get increased life with smaller wire and less costly cloth.

Cost of equipping a screen generally ranges from around $1,000 for a screen of 20 sq ft up to $3,000 to $4,000 for 96 sq ft. Cost of power in many installations is 0.3 to 0.4¢ per ton of feed to the screen. Power demand reflects the screening problem and the size of the heating unit, which ranges from 10 to 30 kva. Heating, however, like other methods of preventing blinding, will not prevent wedging of near-size particles in the cloth nor clogging when the depth of the bed on the screen is greater than recommended practice.

Degradation Removal

Screening out of small pieces resulting from breakage in processing, sometimes called rescreening, can take place at convenient points in the operation. Usually, however, it is done immediately ahead of the loading boom or chute, generally by a separate section of screen in the sizing shaker or in the chute leading to the boom. Where scraper-type booms are employed, they may be fitted with a fixed screen near the end, the fines dropping through to the lower strand for return to the slack or screening circuit. And where coal is loaded by chutes from shortage bins or pockets, fixed sections of plate may be installed in the chute bottoms for degradation removal.

Dewatering and Drying

PURPOSES:

1. Reduction of moisture in the final product and enhancing the benefit to the consumer, particularly in the industrial category, by raising Btu content, reducing freight cost, or better fitting the coal for such uses as the production of metallurgical coke.

2. Elimination of freezing difficulties.

3. Preparing the coal, by such methods as predrying, for added efficiency in screening, air cleaning and the like, while at the same time securing Benefits 1 and 2.

Because the surface area on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¼ in to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further for the reasons set out at the start of this section. Below ½ or ¼ in, freeze prevention requires specific dewatering methods and equipment.

Natural Drainage

Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

The fixed-screen principal for unloading or reducing excess water has been developed into special types of units both here and abroad. The launder screen recently developed for anthracite is made by placing 6-in-high partitions every 6 in along a chute or launder pitched at ¾ to 1¼ in per foot. Screen cloth is tacked over the compartments, which are drilled in the bottom to receive pipe bushings. Only a small percentage of the water and fines is removed in each compartment, resulting in more-even water distribution over the entire screen surface. Also, the bed is maintained in fluid condition, resulting in high screening efficiency.

A combination of "partitioned" and "radial" screens is used abroad and is now offered in the United States for preliminary dewatering of minus ¼-in coal prior to centrifuging (*Coal Age*, September, 1953, p 95). High efficiency with high capacity are claimed for the combination. Belts, as at one U. S. plant, may be used for removing a portion of the water by natural drainage. The belt may be humped in the center, or may be inclined with the coal placed on the side to permit the water to run back over the tail pulley.

For coal larger than ¼ or ½ in, dewatering by natural drainage is quick and complete, and the product, as noted, normally will not freeze unless the cold is severe and lasting. Where the finer sizes are involved and freezing is a consideration, the problem becomes more difficult. However, natural drainage of coal as fine as 1/16 in and 28M to surface moistures of 10 to 12% is being achieved with flotation coal.

The method followed by one anthracite producer, as an example, involves siphoning water off the tops of loaded cars and special caulking of the doors to facilitate draining through the bottom. The process is helped by the flotation reagent remaining on the coal, which facilitates runoff and acts to retard freezing in cold weather.

Mechanical Dewatering

Omitting such processes as thickening and the like (see later section in this Guidebook), mechanical dewatering, frequently set up to complete the job in one pass, is done by screens, centrifuges and various forms of filters, the latter including the high-frequency electrically actuated vibrating type. With all, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means. Some special forms of mechanical dewatering include squeezing flotation coal on a belt conveyor by means of an idler-pulley.

Shaker Screens—Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in. Anthracite shakers for both dewatering and sizing tend to operate at nearly conventional speed and stroke but with only a slight inclination, usually ¾ in per foot. For dewatering only, the speed is increased to 200 to 400 rpm and the throw is cut to 1 to 1½ in, especially for the smaller buckwheats.

Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthracite. In bituminous, however, when dewatering at, say, 28 mesh, the tendency is to use cloth, rod or wedge wire.

When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½ mm or 28M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

Vibrating Screens—The use of vibrating screens for coal dewatering has shown a major increase in recent years, partly reflecting their higher capacity. Both the conventional and special types are employed. One class of special screen is the flat or upwardly inclined type. In both instances, one result of the design is longer retention and greater agitation of the coal to increase the dewatering action. Another class is provided with dams to hold the coal on the screening surface for a sufficient period to insure maximum water removal.

Dewatering results reflect size of coal handled. Where the average size of the feed is around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

Centrifugal Screens—Now being offered for both dry screening and dewatering of the smaller sizes, the centrifugal screen provides results down to as low as 2 to 3% for coal approximately ¼ in in size in some instances, and normally around 5%.

Scalping Service—All types of screens and natural-drainage units may, of course, be used to scalp off part of the water before the coal goes into centrifugal or heat-drying equipment. And by the same token, the feed to screens may be scalped by settling tanks and similar facilities, thus again relieving the burden on the following units and raising their capacity and efficiency.

Centrifugal Driers—Centrifugal driers commonly used in coal preparation are usually divided into the screen and solid-bowl types. A new unit being offered in the United States includes a "rapper" or "bumper" to facilitate travel of the coal down the screen. Centrifuges normally operate on coal less than ½ to ¼ in in size and provide surface moistures of 5 to 7%, sometimes higher and sometimes lower depending upon the size and other characteristics of the feed. Unit capacities range from 20 to 75 tph, as a rule. Coal loss in centrifuging, again depending upon size consist and character, generally is 20 to 30% of the feed, sometimes less and sometimes more.

Centrifuges may be employed for the complete dewatering job. However, there is a tendency to use the centrifuge as a scalping unit ahead of heat-drying equipment, thus simplifying the heat-drying job.

Filters—With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known as a "polisher," is used for the same purpose.

Filters receive feed from settling tanks and thickeners, directly from wash-water sumps, and as effluent from other types of mechanical dewatering units. Common combinations are a centrifuge and a polisher, a thickener and a vacuum unit, or cyclones—single- or two-stage—and vacuum equipment. For typical flowsheets, see section on "Water Handling." With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake, which may be loaded directly or, in some instances, heat-dried alone or in combination with larger sizes.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200M material and the ash content of the dried product, though feed moisture apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating disk-type filters, inloading factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955, p 76.

Thickening and Desliming

Since large volumes of water complicate the final drying job—whether in mechanical or heat equipment—and since very fine material decreases the capacity and efficiency of both mechanical and thermal unit, the trend today is toward thickening or desliming, or both, in advance of final drying.

Thickening—Reducing the water load on the final drying units may be done by relatively simple means, common ones being fixed sieves or mechanical or electrical screens—usually both—ahead of the drying unit. For even greater water removal, plus also desliming, the equipment that may be employed includes drag-conveyor settling tanks, thickeners and cyclones, which may be preceded—and usually are—by fixed sieves and operating screens for unloading.

Examples of thickening before drying include:

1. Silt from tables and flotation equipment, at a rate of 102 tph in 1,440 gpm of water to eight 14-in cyclones; thickened cyclone underflow (101 tph maximum in 900 gpm) to three solid-bowl centrifuges (*Coal Age*, May, 1955, p 78). Desliming at this plant, incidentally (see flowsheet p 113 of this issue), is done ahead of the cleaning units.

2. Fine coal (¼x0) to drag-conveyor settling tank, with underflow to centrifugal dryer, overflow back to wash box and effluent from top of tank to settling pond (*Coal Age*, June, 1955, p 68).

3. Clean ⅜x0 slack by 6-in pump, 2,000 gpm, to 6x16-ft dewaterizing vibrator with ¼-mm stainless deck. Overproduct to two centrifugal driers. Underflow by 6-in pump, 1,425 gpm, to five 14-in cyclones, 35-psi feed pressure. Cyclone underflow to 8-disk 8-ft 10-in vacuum filter producing cake with about 25% moisture. Part of cyclone overflow returned to coarse-coal settling cone to replace water used in pumping slurry to clean-coal sump in fine-coal plant; remainder by 6-in pump, 1,100 gpm, to five batteries of 22 3-in cyclones, 40-psi feed pressure. Cyclone underflow to vacuum filter; overflow used for wetting raw feed to fine-coal plant. Vacuum filtrate (approximately 0.52% solids) to sump providing table dressing water. Final drying step is combining centrifuge and filter products in two flash units reducing moisture from around 12 to about 3% (Matthew Turkovich, 1956 Coal Convention, American Mining Congress).

Desliming—Removal of very fine material prior to further drying may be done as the first step in the fine-coal processing cycle, or directly before the material to be dried goes into said drier.

Desliming before processing at one new plant is done in two bowl-type desilters (p 00). The desilters overflow minus 100M, approximately 80% of which is minus 200M. The coal then goes to the table plant, which is followed by four solid-bowl centrifugal filters, with a fifth as a spare. Filter effluent is returned to the clarified-water circuit. "The uniform deslimed feed not only promotes high efficiency in cleaning fine coal, but materially improves the efficiency in mechanical dewatering by solid-bowl centrifugal filters, giving an overall performance ranking with the best in the industry" (Paul L. Richards and Andrew F. Hamlet, 1956 Coal Convention, American Mining Congress). The final dewatering step at this plant is performed by thermal driers reducing moisture to approximately 3%.

Thickening prior to filtering at another plant is handled by a battery of three 20-in cyclones in series with eight 14-in cyclones (*Coal Age*, December, 1955, p 70). The cyclones remove approximately 150M from a 28M feed, and handle approximately 1,800 gpm with a pressure of 35 psi on the outlet side of the 14-in units. The 14x150M cyclone product then goes to two top-feed-reservoir filters reducing moisture to approximately 18%. Cake is stored in a special tub-shaped bin equipped with a boom-type scraper conveyor. The bottom of the bin is shaped so that when the conveyor is lowered onto it the fines may be removed completely. Other drying equipment in the plant includes centrifuges for ⅜x0 and thermal equipment handling both centrifuge and filter products, reducing the moisture to approximately 3½%. Feed moisture is approximately 9%.

Warm-Water Processing—Experience at a number of plants indicates that the efficiency of mechanical dewatering by screens, centrifuges, etc., is higher in summer

when the water temperature is up. In other words, the water is easier to shake or spin off. Advantage is taken of this fact at the plant summarized in the preceding paragraph, where dust is removed from the drier exhaust by a combination of cyclone collectors, and water sprays are used to cut down the speed and volume of the first exhaust to the atmosphere. Four thermal driers each exhaust 50,000 cfm at 200 to 250 F. The exhaust carries with it 14Mx0. Two cyclones are provided for each of the four drier exhausts, after which the gases go to a concrete duct leading to a silo chimney. Sprays in the concrete duct reduce gas temperature from approximately 180 down to 110 F. The warmed water, with its temperature raised about 45 F, is returned to the fine-coal washing circuit, raising its temperature by up to 13 F in winter. This warmer washing water and resulting warmer coal facilitates mechanical dewatering, apparently by reducing surface tension.

Heat Drying

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes. In this process, the coal is subjected to hot gases at temperatures slightly above the temperature at which volatile matter is distilled off of the coal. Time is a major factor in preventing distillation, or cooking, of the coal and consequently the aim is to keep it as short as possible, though longer periods are possible with reductions in temperature.

Types of heat driers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside.

2. Screen, involving a reciprocating screen as the carrying medium. In most instances, the gas is pulled down through the bed and the drying action is of two types; evaporation and, to some extent, mechanical as a result of the screening action and the scrubbing action of the gas. When the gas flow is interrupted by an appropriate valve and then is resumed, squeezing also takes place. As the coal gets finer, evaporation becomes relatively more important, and consequently, fine-coal screen driers are designed for longer coal retention as a rule. New designs include a step between the two screens to turn the coal over.

Depending upon size of the unit, also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows in steps down through a vertical shell, resting for an interval on each shelf or step in one type and on a bottom shelf in another.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and downdraft gas flows, the down being the second stage and designed to permit maximum mechanical dewatering through the wire-mesh belt. The coal bed in the second pass also acts as a filter to catch dust from the first pass.

5. Suspension, in which the coal is introduced into an upward-flowing stream of gas. In one type, the coal is placed in the gas at the bottom of a drying column. Drying takes place almost instantly and the coal is separated out in a cyclone collector equipped with a rotary discharge valve. In another type, the coal flows down over the flights of an inclined conveyor and at the same time is moved sideways to the discharge point. Housing design is such that only the smallest particles escape from the chamber. Both driers are widely used for the finer sizes of coal.

As noted in the preceding section on "Thickening and Desliming," as well as an earlier section on "Mechanical Dewatering," there is a trend toward going beyond the usual fixed sieve or screen for unloading excess water prior to heat drying. Thus, as the examples given under "Thickening and Desliming" indicate, the heat drier may be preceded by thickeners, centrifuges, cyclones or vacuum filters, or a combination of filter and one of the other units. Drier capacity is raised and drying efficiency is increased.

Dust Suppression—Dust is a problem with practically all heat driers, and particularly with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see section under "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet-and dry (tumbler-type) collectors.

The problem of disposing of the collected material has been solved in at least one instance where water-spray equipment was installed by cleaning it in flotation equipment and dewatering it on a vibrating screen. At another plant, the primary dry cyclone product is used for drier-furnace feed or is included in the shipped coal, while the exit gases are polished up in wet "clones." The spigot product of the wet units is pumped to refuse.

Crushing

PURPOSE: Conversion of unwanted or slow-moving natural coarse sizes into smaller sizes desired by the market, as distinguished from crushing for process purposes, such as, middlings retreatment.

Although crushing or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning, and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the size that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, especially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "Rescreening").

A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without excessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

Flexibility in sizes shipped may involve considerable labor and loss of time in varying crusher openings. New

models provide gear mechanisms for attaining such changes quickly and while the crusher is in operation.

Rescreening

PURPOSE: Production of additional and sometimes special sizes not normally provided by the regular sizing equipment.

The growth of the domestic stoker was in large part responsible for the growth of rescreening in the bituminous field. With a longer size list, anthracite, in contrast, had no need to change its practice, beyond doing additional crushing, to satisfy stoker customers. Making bituminous stoker normally involved at least dedusting or the removal of fines under, say, ¼ in. Also, many mines going into stoker had the problem of making a product with a top size of ¾, 1 or 1¼ in out of, say, 2-in screenings. Thus, rescreening received a large part of its momentum and the process then was broadened to provide what might be called specialty sizes for other purposes.

The vibrating screen, normally receiving its feed from the main sizing shaker, is the most-used type of rescreening unit in the bituminous fields. Air also has been used for dedusting at, say, 48M, in making the smaller stoker sizes. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands. Over and through products from rescreening may be sold as separate grades but more commonly are run into slack and screenings shipments for industrial purposes.

Mixing and Blending

PURPOSES:

1. In blending, to achieve a high degree of uniformity of ash, sulphur and other constituents in the finished product. Blending is done mostly where metallurgical coal is involved and, as previously noted, is accomplished largely at the raw-coal end. However, some metallurgical plants also blend the cleaned product a second time before loading.

2. In mixing, to provide sizes better tailored to the needs of the consumer.

Most of the mixing is done on the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages that naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that the consists can be absolutely accurate and also absolutely uniform from day to day or shipment to shipment.

Prescription mixing normally is limited to the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by preliminary crushing and rescreening facilities. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders that have been equipped with variable-speed drives.

Dustproofing

PURPOSE: Preventing the emission of objectionable volumes of airborne dust at the point of consumption by making dust and breakage resulting from handling and storing stick to the larger pieces.

The principal materials used for dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other chemicals and materials, including cornstarch and molasses, papermaking by-products and so on, pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack on metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot- and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature at the point of application.

Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

Application—For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

PURPOSE: Elimination of the labor trouble and adverse consumer reaction involved in the freezing of moist or wet coal in severe weather.

Where heat drying is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment

is affected not only by the climate encountered but by industry custom and customer preference. Since anthracite, for example, has been shipped wet for many years and consumers have become accustomed to the situation and are prepared with the necessary thawing equipment, there has so far been little stress on freezeproofing in that industry.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freezeproofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

	Lb CaCl per Ton at Specified Temperatures, Deg. F		
Moisture	+32 to +15	+15 to 0	0 to −15
3%	3.0-4.5	4.5-6.0	6.0-7.5
6%	6.0-9.0	9.0-12.0	12.0-15.0
9%	9.0-13.5	13.5-18.0	18.0-22.5

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil treatment, using the normal spray oil, will retard or prevent freezing if there is no great excess of water Used crankcase oil or a similar type also has been sprayed on the interior of cars to prevent coal from freezing to the metal and thus making it easier to unload since, in some instances, the freezing is limited to a crust a few inches thick and the car can be unloaded cleanly if sticking on the sides and bottom can be prevented.

Loading

Anthracite is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size, though a growing number of bituminous plants are providing pockets for certain sizes—usually stoker or other sizes in the smaller range. Loading of two cars on the same track also is practiced to some extent at certain bituminous plants by conveying one size to a pocket above or below the regular loading point.

Where only one size is produced, or where storage bins are provided for one or more additional sizes, loading of an entire shift's run of railroad equipment can be done with the new elevated shuttle belt without moving a single car once they are set in by the railroad. One late shuttle-belt installation (*Coal Age*, March, 1953, pp 94-95) is based on elevated narrow-gage track 760 ft long with a 380-ft-long 30-in reversible belt conveyor on wheels operating on it. The belt is between two tracks accommodating 20 cars each, and coal can be loaded either way at either end of the belt by pairs of discharge chutes and diverting gates. One man at a push-button station controls belt operation and the operation of the elevating conveyor feeding coal onto it from the preparation plant.

Booms have long been used to lower the coal into railroad cars with a minimum of breakage at bituminous plants, and there is a tendency to extend their use to the smaller sizes, particularly stoker, though the chute still is the popular loading device for slack, screenings and other smaller sizes. Belt, apron and scraper-type booms are employed, with shaker booms as an added starter. The first two lend themselves to hand picking on horizontal sections. The third can be equipped with degradation screens, the breakage being returned to the mixing conveyor or other point by the bottom strand.

Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers. The latter, among other things, reduces size segregation and improves appearance. Provisions for changing cars without stopping equipment include pantograph diversion chutes on booms which automatically come into position as the boom is raised. Other types of diversion chutes provide the same benefits with booms and also with chutes.

Truck Loading

Loading of trucks requires somewhat different practices. It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

In the anthracite field, a new six-bunker plant is designed so that all operations are conducted by two men and accurate dispensing of orders is controlled by presetting dials to control flight feeders delivering at rates up to 5 tpm (*Coal Age*, January, 1954, pp 68-69). The dials are calibrated to tenths of a ton and trimming to adjust weight is seldom necessary. Coal is delivered to the truck plant by two 24-in belts housed in corrugated pipe, and is distributed to the bunkers by two shuttle conveyors.

Tramp-Iron Removal—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

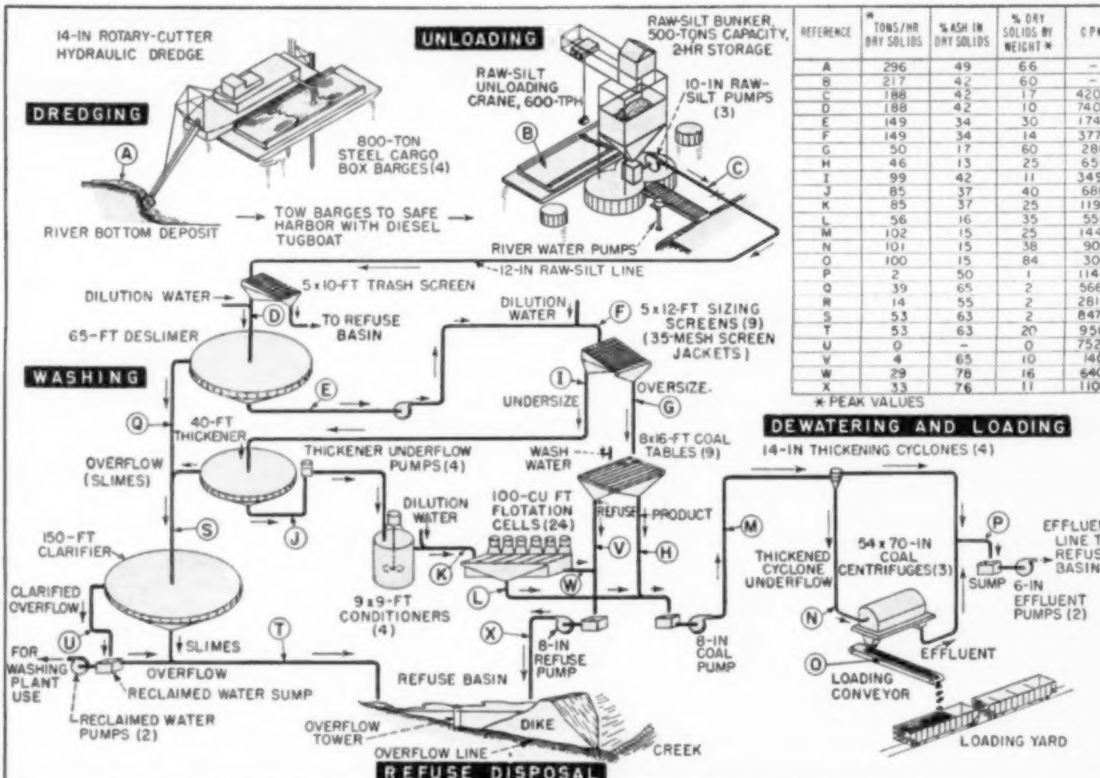
Degradation Removal—See "Clean Coal Sizing."

Water Handling

Questions involved in water handling at plants cleaning by wet methods include:

1. Fresh water supply and treatment.
2. Clarification and recirculation.
3. Final disposal where circuits are or cannot be closed.

Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.



REFERENCE	* TONS/HR DRY SOLIDS	% ASH IN DRY SOLIDS	% DRY SOLIDS BY WEIGHT *	GPM *
A	296	49	66	–
B	217	42	60	–
C	188	42	17	4200
D	188	42	10	7400
E	149	34	30	1740
F	149	34	14	3770
G	50	17	60	280
H	46	13	25	650
I	99	42	11	3490
J	85	37	40	680
K	85	37	25	1190
L	56	16	35	550
M	102	15	25	1440
N	101	15	38	900
O	100	15	84	300
P	2	50	1	1140
Q	39	65	2	5660
R	14	55	2	2810
S	53	63	2	8470
T	53	63	20	950
U	0	–	0	7520
V	4	65	10	140
W	29	78	16	640
X	33	76	11	1100

* PEAK VALUES

DESLIMING may be done to increase **both cleaning and dewatering efficiency in handling fine coal. In addition to desliming,** cyclones are used for preliminary dewatering prior to final drying in this plant.

Sources of makeup water are:

1. Deep wells.
2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.
3. Mine water, if available.

Water from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid, though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in the plant circuit should be between 8.0 and 8.5.

Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel, for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shutdown time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for treating water efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow. Impounding dams, if possible, and artificial ponds and storage tanks are among the answers. In hilly country where dams are not feasible, wood-stave or other tanks are employed by some operators to store up to, say, ½ million gallons. With any type of system, a small surge tank should be provided at or in the plant to receive the fresh water, which usually is added—at least in part—through clear-water sprays on the clean-coal classifying screens.

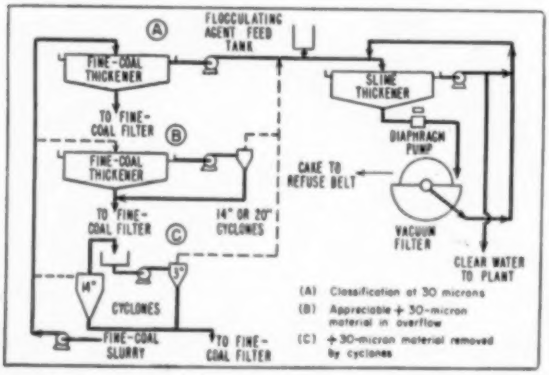
Handling Wash Water

Stream-pollution regulations and the need, in many instances, for decreasing the loss of good coal to the refuse have resulted in major activity in the processing of wash water. A third reason for processing is to prevent the buildup of solids in water recirculated to washing units, since excessive buildup may materially affect the gravity of separation and consequently cleaning results. Available data indicate that many preparation men regard a solids content of more than 15 to 20% as excessive, while some try to keep it under as low as 5%.

Closed circuits frequently are mentioned as objectives in water handling—and in many instances are practicable, though not in all. Reasons for circuit closing include: (1) elimination of discharge to streams, (2) reducing makeup water to that required for pump glands and other essential uses, (3) recovery of coal and (4) recovery of medium (see p 104). As a corollary of closing, however, it is necessary to remove at least part of the solids, especially if clay and mud are present, to prevent solids buildup and a change in the gravity of the cleaning bath.

Closing a circuit may either be impossible or not desirable, however. If, as previously indicated, moisture on the coal leaving the plant is equal to that entering the plant, the quantity of makeup water that can be added without bleeding is nil. Thus, even gland-water requirements, if included in the water circuit, can force bleed under some circumstances.

Practice and field custom also may result in bleeding of some to considerable quantities of wash water. It may, as an example, contain large quantities of high-impurity fines that would be difficult to clean even if recovered,



SOLIDS REMOVAL from wash water by flocculation and filtration.

and bleeding to ponds, if space is available, might be the most economical disposal system. And under some conditions, it may be necessary to feed excess fresh water into the system for essential services, even if it is not required to rinse off clean coal and improve appearance.

Solids Reduction—The goal in this operation, in contrast to fairly complete removal to meet pollution regulations, for example, is keeping the solids content of recirculated water to a reasonable figure: not over, say, 20%. The old-reliable conical or drag-conveyor settling tanks are standard equipment units for this purpose. Examples of other equipment and facilities include, at one plant, a 125-ft thickener for clarifying recirculating water and a settling pond to clarify waste water, and at another a thickener, large and small cyclones and vacuum filters, plus two settling ponds. The goal is 15% solids in the recirculated water used for washing, and to achieve this goal the system is bled about twice a shift when the content goes above this figure. The bled-off material is recovered from the ponds for loading.

Flocculation—Where natural settlement is depended upon for removing solids from wash water, results reflect the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along the settlement.

Solids Removal—Complete removal of solids may be desirable for two reasons: (1) salvage of good coal from the wash water, or (2) conformity with pollution regulations. Where coal is concerned, the same installation ordinarily accomplishes both results. Where refuse is involved, the only goal is meeting stream-pollution regulations.

Settling ponds, where space is available, are perhaps the simplest method of attaining sufficient solids removal to conform to pollution regulations. In some instances, they may be the cheapest, though not always. Their construction involves some expense, and if the capacity is limited they must be cleaned out from time to time. With ponds also, any fines that reach them, if of good quality, are either lost or can be recovered only at some added expense. Consequently, there is a trend toward extracting at least part if not all of the solids from the water before running it to the pond.

Equipment for accomplishing solids removal before discharge to the pond may be merely the old reliable conical or drag-conveyor settling tank. Other units are thickeners, hydraulic or nonhydraulic classifiers, cyclones, and filters of various types. Combinations of equipment to keep the final discharge to the pond as low in solids as possible, and consequently keep pond size to a minimum while at the same time lengthening its life to the maximum include, at one operation, a dewaterizer, centrifugal driers, large and small cyclones and a vacuum filter. The flow is summarized in Example 3 under "Thickening and Desliming" (p 109).

Underflow from the small cyclones is the only bleed from this plant. The solids concentration is approximately 0.45%, about 90% of which will settle in 1 hr and 10% will remain in suspension. With an average bleed of 50 gpm, the very small pond is expected to have a life of 4 yr. Solids content of the overflow from the pond to the stream is 0.045 to 0.082%.

As another example, bleed or waste water may be run to a cyclone installation (*Coal Age*, December, 1954, p 62), followed by a vibrating screen to receive the underflow—dewatering it and discharging it to refuse or clean coal. The screen underflow may be recycled to the cyclones, while the cyclone underflow, containing minus 200M, goes to the pond. The 200M, however, stays in suspension longer, and to reduce the possibility of an overflow containing a heavy percentage of such material, flocculation may be the answer.

Closed Circuits—Three variations in a solids-removal flowsheet involving flocculation and complete closing of the circuit (*Coal Age*, January, 1955, p 76) are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent of two-stage cyclone concentration is employed.

Three water-handling systems based on filters for final recovery of the solids also are shown in the accompanying illustrations. Suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond, the three systems involve:

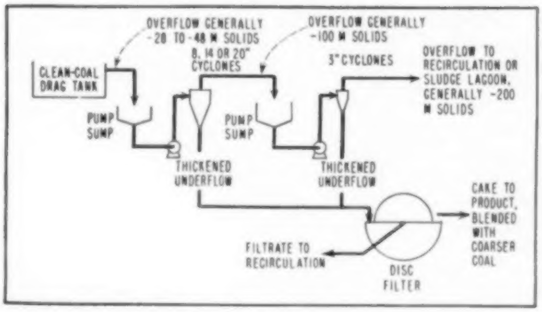
1. Cyclone classifiers in conjunction with gravity classifier or thickener delivering thickened underflow for filtration.

2. Cyclone classifiers in conjunction with filters. The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. Thickeners and cyclones for preliminary concentration. Better filter operation is one of the advantages.

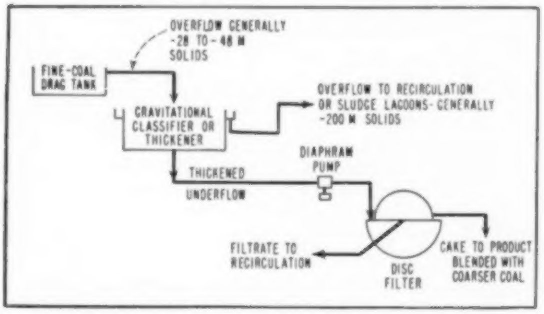
Water Circulation—Head tanks with automatically controlled pumps provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs. Provisions for coping with water and solids include the proper types of metals or the proper linings in pumps, as well as plastic, rubber and other special forms of pipe for certain applications to resist both wear and corrosion. Rubber-pinch and orifice-type valves solve some of the flow-control problems and provide good regulation, in addition to reducing the valve maintenance problem.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction, and, as indicated, the coal may be returned for re-processing.

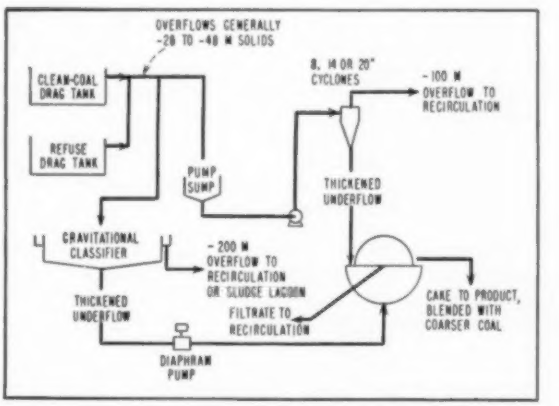


GRAVITY CLASSIFIERS or thickeners for preliminary classification.

Vacuum-Filtration Systems



CYCLONES for preliminary classification



GRAVITY THICKENERS and cyclones for preliminary classification.

Sludge Recovery

PURPOSES:

1. **Water clarification.**
2. **Recovery of saleable material.**

Normally water clarification and the recovery of fine coal, whether called sludge, slurry or some other name, go hand in hand, although if clarification only is the goal, the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, say, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake, especially if it can be shipped without further processing. Even where processing is required, the quantity and character of the fines may warrant a substantial investment, particularly if clarification also is required or is desirable.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. Cleaning equipment include flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks, an increasing practice in recent years. Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for conducting this operation by froth flotation, which may be followed by heat drying.

Refuse Disposal

The dump truck has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

Pumping of refuse is growing, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Even with other methods of disposal, especially where large mine rock is handled, it may be economical to crush with rock-type equipment, such as jaw or gyratory crushers. Easier handling, a more-compact pile and greater ease in maintaining a running surface where trucks are used are among the arguments in favor of crushing not only mine rock but also large refuse of any nature.

Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off. Properly equipped, the bulldozer also may be used to shift track where larries are employed. A few refuse trucks themselves have been fitted with front blades or with special tailgates for spreading, particularly if the material handled tends toward the small side.

To save handling mine rock through the regular preparation disposal facilities, special rocker dumps may be installed, if conditions otherwise permit, to permit dumping directly from the mine cars onto and over the bank for easy final disposal.

Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by

stepping, trenching and filling and covering with earth as conditions dictated.

Under some circumstances, the disposal problem may be solved by converting refuse into a lightweight aggregate and selling it. Requisites are refuse of the proper type and a market within practicable shipping distance. One plant of this type is described in an article in the November, 1955, issue of *Coal Age*, p 78.

Power

Voltage—Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 v should be used for certain large units, such as pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

Transformer Location—Packaged substations with oil-filled transformers are available for outdoor service, with non-flammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with non-flammable transformers is the general choice, principally because it can be placed closer to the center of the load.

Controls—Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in location and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered.

Capacitors—The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

PURPOSE: Efficient plant operation with no or a minimum of interruptions. A collateral goal is conduct of maintenance with a minimum cost for labor and materials.

Maintenance is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. Rusting of the exterior and interior, including structural members and equipment, as a result of rain, snow and water.
2. Corrosion from acid water and, on occasion, from the gases given off by burning refuse dumps. Acid-water corrosion, of course, shows up most in washers, screens, tanks and other facilities exposed to water.
3. The effects of heat and gases involved in heat drying.
4. Wear from the handling of coal and rock.
5. Lack of lubrication, overloading and other abuse, faulty electrical service and the like, resulting in motor and machine breakdown.

Maintenance Factors

All wear and corrosion, cannot, of course, be eliminated. However, consideration of the causes and their effects logically indicate the remedies which, in large part, are preventive in nature. In other words, use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. Location of heavy equipment, particularly of the rotating or reciprocating type, on or as near ground level as possible: cuts structural cost and reduces the effects of weight, motion and vibration.
2. Bracing, steel weight, balancing and damping to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.
3. Use of protected steel and special roofing and siding materials, including asbestos-cement and aluminum.
4. Protective coatings and paints for steel exposed to rain, moisture, gases and the like. Paints and coatings normally, of course, are not for surfaces exposed to moving coal or rock, water carrying solids and the like.
5. Neutralization of acid water with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.
6. Use of corrosion- and abrasion-resisting materials for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.
7. Use of linings to resist wear and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Entire loading pockets have, on occasion, been built of glazed tile to combat wear and corrosion. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural accompaniments of the broad use of lining materials.
8. Use of totally enclosed, splashproof and other special motors for dusty, wet and similar locations, plus moisture- and dust-proof controls or the location of controls in rooms with blowers using filtered air and maintaining a slight positive pressure inside the rooms at all times.
9. Good lubrication with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor as a result of demonstrated benefits, and have proved their ability to handle even such difficult problems as underwater bearings in settling tanks.
10. Regular inspection and cleaning of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Actual conduct of maintenance is facilitated by plant design and maintenance tools and facilities. A design which provides adequate room around the various units eases inspection and cleaning, and makes repair and replacement easier when necessary. An elevator in the

larger plants, in addition to the usual cranes and blocks, facilitates moving equipment, materials and tools in and out. Monorails over centrifugal driers, screens, crushers and so on facilitate changing jackets, segments and other removable parts.

Electrical and compressed-air outlets at strategic points facilitate the use of power tools in maintenance. And, since welding and cutting play such vital roles in preparation maintenance and in plant changes, there is a real advantage in piping gas throughout the plant and having one or perhaps two or more electric welders at strategic points. Good lighting, in addition to promoting safety, facilitates checking on equipment operation, cleaning, and necessary repair and replacement.

Quality Control

PURPOSES:

1. Attainment of the desired preparation standards with a minimum of deviations and a maximum of efficiency.

2. Securing data on the quality of shipments for possible use in adjusting complaints and as a final check on preparation performance.

Control of preparation results starts, as indicated in earlier sections of this Guidebook, by such steps as blending, proper picking practices, uniform feed to cleaning units, proper adjustment of cleaning equipment, and so on. Checking on the results and getting records on shipments, the subject of this section, is largely a means of making sure that all the other steps are being carried out properly.

Checking and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection—by operators who know their business—of the feed and draw material can reveal changes in conditions immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

Sampling—Where the tonnage is at all large and a careful check on quility is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, he also may run sink-and-float tests and prepare samples for more-elaborate chemical tests.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump—and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm. which is swung through the coal stream at the specified intervals. Labor is saved and the sample tends to be more representative.

If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample-preparation equipment—crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation. Among other things, this permits running the coal left over after splitting directly to the car.

Test Procedure—Samples for checking cleaner operation normally are processed by sink-and-float. The equipment, which includes factory-made units designed specifically for the job, may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples, provided testing is carefully done and the character of the refuse is not subject to sharp fluctuations.

Checking the efficiency of washer operation also requires testing of refuse to make sure that coal loss is not excessive, and also of the raw feed to determine whether a change in its character will establish different limits on the results that may be expected or will necessitate readjustment to attain the original standards.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories. An example is the subject of an article in the April, 1950, issue of *Coal Age*, p 90.

Laboratories normally are placed in separate structures although a few have been built in the preparation plants themselves. The added convenience is said to more than compensate for the necessity of careful enclosure to keep out dust and noise, and the cost of methods of insulating the laboratory from vibration and motion.

Sizing Control—Since the accuracy of screening can have a major effect not only on realization but also on customer acceptance, quality control must take in size checking also. Facilities will vary with the circumstances at the individual plants but they should at least include a test-screen unit, which may be purchased from various manufacturers.

Records—The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.

The Maintenance Guidebook

THE MEANING of "maintenance" in coal mining has changed radically in recent years as a direct result of increasing wage rates, the rising use of machinery to offset these increases, and the change to the day-rate method payment, which increases the cost penalties suffered by the company when production is interrupted. Now, "fixing" a machine after trouble occurs, once the leading idea in maintenance thinking, has dropped to last place in the ranking of the three major objectives in maintenance:

1. Prevention of machine breakdowns. This normally is termed "preventive" maintenance but more properly might be termed "production" maintenance, since production and cost depend upon keeping the machine running at full capacity as much of the time as possible.
2. Improvement in machine condition, if possible, or at least preservation of original machine condition and capacity during its useful life, which life, on this basis, is determined by obsolescence rather than wear.
3. Repair after breakdown.

Breakdown Cost the Key

Prevention of machine breakdowns, or "production" maintenance, quite properly holds first place in organizing maintenance. The importance of this principle becomes apparent with a little study of breakdown cost. A loss of an hour's time, for example, can mean a wage outlay with a 10-man crew, of approximately $25 for which no production is received. Or, looking at it another way, if the unit averages a ton a minute, an hour's delay would mean a loss of 60 tons, increasing the section labor cost per shift, depending upon travel time, 8 to 10c per ton in this instance.

The key is getting the maximum production for the money that must be laid out whether coal is run or not. Wages and salaries are the principal items, but overhead, power for pumping and ventilation, etc., must be included.

The "chain-reaction" principle also has become more and more a factor in maintenance thinking as machines have taken over more of the production load, as more and more productive capacity has been concentrated in individual units, and as the day-rate method of wage payment has become almost universal. Thus, for example, a fall on a loading station or a slide in a strip pit hurts much more now because of this concentration of production and because a much-greater part of the money outlay continues while production stops. Thus, maintenance becomes even broader in scope when keeping production machines running at rated capacity becomes the overriding goal, as it is today.

Getting Efficient Maintenance

Nothing being perfect, breakdowns and production interruptions cannot be completely eliminated, but they can be kept to a minimum by a reasonable expenditure of time and money. As an example, a month's report on six continuous miners working two shifts a day at one operation where tons per man average for the units ranged from 41.0 to 57.3 showed a breakdown total of 150 hr 29 min out of a total of 1,848 possible producing hours, or 8.2%.

But while keeping down time to a minimum is the major goal, a second one is conducting maintenance work with a minimum of manpower and materials.

What can be done in these and other directions to keep production interruptions to a minimum—and to do it at minimum cost—is the goal of the material which follows.

Reports and Records

PURPOSES:

1. Providing data on the causes of delays and time lost, thus permitting concentration where the greatest gains can be made.

2. Providing information on equipment condition as a means of forestalling breakdowns.

3. Providing information on the cost of repairs, overhauls and the like as a further check on whether proper operating and maintenance practices are being followed.

IT MIGHT BE SAID, in fact, that without proper reports and records, even though they involve paper work, no real progress can be made in maintenance. But while paper work is essential, careful study of the types and numbers of forms will reduce it to a minimum—and will make that minimum more valuable.

Types of Reports and Records

Daily Delay or Operating Report—In breakdown prevention—the No. 1 goal in maintenance—the daily delay or operating report is a must. It shows what the mechanical

Maintenance Foundations

Delay Reports and summaries show what is happening and where to concentrate

SECTION FOREMAN'S DAILY DELAY REPORT

MINE ______________________
SECTION ______________________ DATE ______________
FOREMAN ______________________ CARS LOADED ______________
SHIFT ______________

Type Delay	Time	Remarks

REPAIRS NEEDED ______________________

CONTINUOUS MINER TIME STUDY

Date ______________ By ______________
No. Place Shift

TIME LOST									Total Time Lost	Total Time Operated	Total Time
Shuttle Car	Bolting	Timbering	Moving	Break-down	Power	Water	Changing Bits	Oil & Grease			
Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.

Progress: ______________ ft. hdg.
______________ ft. A.C.
______________ ft. x.c.
______________ ft. room
Total Feet ______________

No. Tram Cars ______________
No. Shuttle Cars ______________
Approx. tons per car ______________
Approx. total tons ______________
Tons per man day ______________

Report below only breakdowns:

No. Men		Time	Amount
______	Foreman	______	______
______	Operator	______	______
______	Operator Helper	______	______
______	Shuttle Car Operator	______	______
______	Loader Operator	______	______
______	Car Trimmer	______	______
______	Others	______	______
		Total	______

Cost Per Ton ______________

Bolting: No. Bolts ______________

No. Men	Classifications:	Time	Amount
______	______________	______	______
______	______________	______	______
______	______________	______	______
		Total	______
		Grand Total	______

Operator: ______________

CONTINUOUS MINER TIME STUDY

No. 1
Month of ______________, 19__
______________ MINE

DAY SHIFT

Date	No. Men	TIME LOST Shuttle Car	Bolting	Timbering	Moving	Break-down	Power	Water	Change Bits	Oil & Grease	Total Time Lost	Total Time Operated	Total Time	No. Feet Advanced	No. Shuttle Cars	Tons Per Car	Total Tons	Tons Man Day	Total Cost	Cost Per Ton	REMARKS
1																					
2																					
3																					
31																					
Total																					

No. 1
Month of ______________, 19__

NIGHT SHIFT

Date	No. Men	TIME LOST Shuttle Car	Bolting	Timbering	Moving	Break-down	Power	Water	Change Bits	Oil & Grease	Total Time Lost	Total Time Operated	Total Time	No. Feet Advanced	No. Shuttle Cars	Tons Per Car	Total Tons	Tons Man Day	Total Cost	Cost Per Ton	REMARKS
1																					
2																					

and electrical failures were and how much time was lost with each. Also, these reports may be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

The daily report may be rather simple, per the accompanying example, which concentrates on production and delays only. Or, as in the second example illustrated, it may include details on labor, number of roof bolts installed and so on. In this particular example, two of the items are tons per man and section labor cost, which can serve as a sharp reminder of the value of keeping delays to a minimum.

For top management, and as a running record of results, the delay reports should be combined into weekly or monthly summaries. To accompany the daily continuous-miner report illustrated, for example, a monthly sheet, also shown, pulls everything together in one place. With summaries such as this, it is easy to focus on trouble spots and determine, for example, if a new material, special repair skill or other steps are necessary.

Automatic records of operating and delay time are possible on certain types of equipment. Examples are swing recorders for shovels and draglines, and electric clocks hooked up with feeders in preparation plants so that they run only when the feeders run. Such equipment eliminates human errors in computing or entering lost time and, in the case of the feeder clock, permits checking on how the plant is doing at any time merely by a glance. Swing charts, on the other hand, permit detailed study of what has been happening if it should appear necessary.

Work-Needed Report—To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on the regular form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report—As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. An example is illustrated elsewhere in this section. The frequency of such reports can vary from daily to monthly or longer, with a week or a month as the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over. Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjustments and repairs, and can note larger jobs that may require taking the unit out of service.

Unit Cost Record—There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic—in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages:

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.
2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdowns.
3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.
4. Data on the value of special materials—for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts used and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly—for the superintendent and other officials having jurisdiction.

Record Distribution—As implied in the preceding paragraph, reports and records can be fully effective only when they, or the data from them, are regularly routed to the responsible operating or maintenance heads. Thus, for example, the superintendent or other operating head should receive weekly or monthly delay summaries and unit-cost records. Distribution to other officials, including face foremen, may be helpful as an incentive and also to inform them when delays or costs begin to mount up.

Who Should File Reports

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

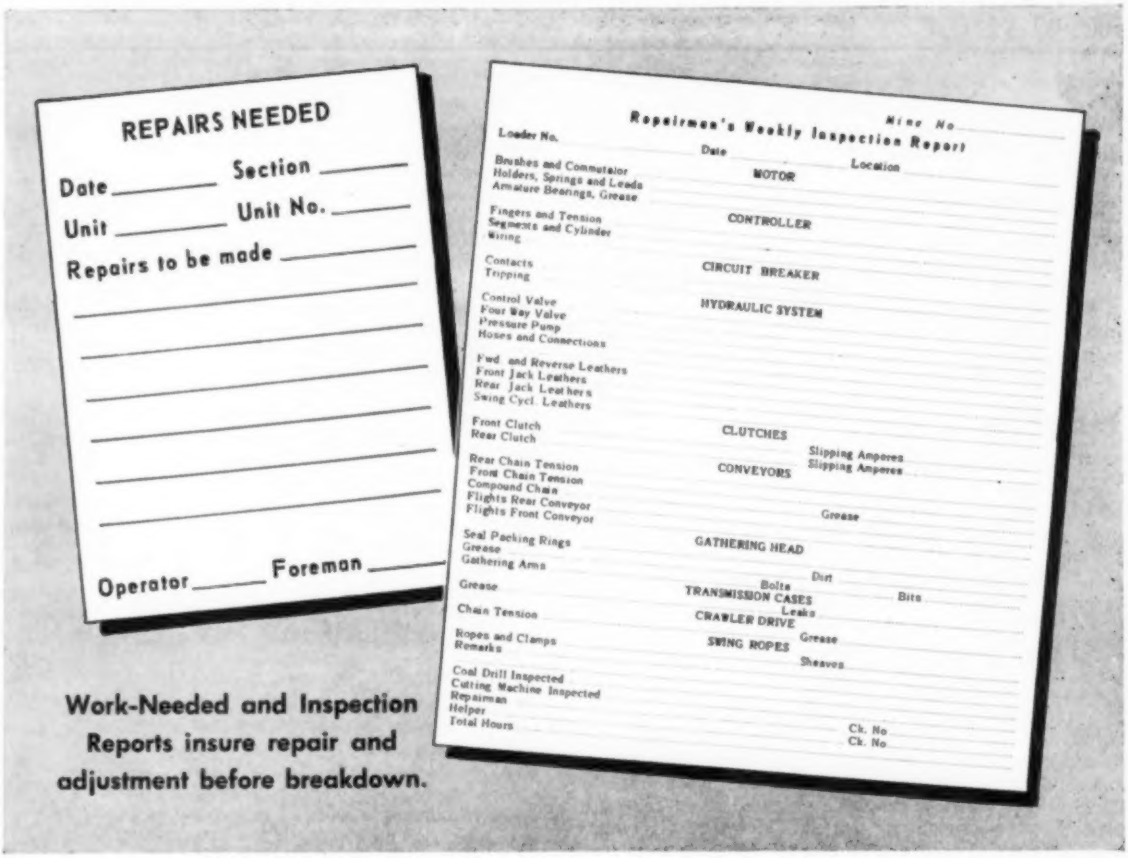
Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focusing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.

Responsibility

RATHER THAN EMPHASIZING what any particular department should do, the goal in maintenance is the program—what it should be and what it should do. Once



Work-Needed and Inspection Reports insure repair and adjustment before breakdown.

the program is fixed, the responsibilities of the operating and maintenance departments become clear. Under this approach, the responsibility for an effective maintenance program is one for the operating management, which also exercises the final authority. For example, experience at one operation indicated that on the working section the face boss should be in control of all maintenance men and functions on the section. Divided responsibility resulted in confusion, buckpassing and failure to keep on top of the job.

But while final authority logically rests with the operating department, the cost, capacity and complexity of the new machines now handling coal production require additional skills and manpower to keep them running at rated capacity. Consequently, the responsibility for sustained production which only the maintenance department can discharge is increased. In other words, as a practical matter, production depends to a major extent on maintenance, and the maintenance department must be organized and staffed accordingly.

For an indication of how this works out at the face, the foreman has the responsibility for seeing that his unit is operated with a minimum of delays—in other words, that it produces at the maximum rate.

Organization and Manning

GETTING MAINTENANCE DONE promptly and effectively, as distinguished from organization of the staff, might logically be approached by considering the type of work necessary. This leads to the "three-echelon" system illustrated, which breaks down as follows:

First Echelon

Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

First-echelon work also includes servicing the equipment, such as, lubrication, checking and inflation of tires (trucks at strip pits and rubber-tired equipment underground), cable maintenance and repair, and other similar operations.

Typical setups for manning face maintenance are one mechanic or electrician for one or two units, underground, and one or more men for each major class of equipment in the larger strips—for example, (1) shovels and draglines, (2) drills, pumps and compressors, and (3) trucks, tractors, graders, etc. However, organization is subject to considerable variation, and at smaller operations, or at operations with certain types of equipment of a rather simple and rugged nature, running maintenance may be handled by one man or one man and a helper.

Whatever the type of operation, however, the basic principle is assignment of sufficient specialists to a unit or a group of units to keep breakdowns to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction.

Second Echelon

Major inspections involving some opening of cases and enclosures, and also major repair or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

Such work normally falls to special groups, which may be: (1) permanent task forces or "bull gangs," (2) special groups of men normally employed in the underground or field shop—or perhaps the main shop, or (3) temporary groups made up by assembling the regular section or pit men on off-shifts or idle days. Similar task forces normally handle the maintenance of preparation plants.

Third Echelon

Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage, yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

Since overhaul, in addition to skill in dismantling and assembly, requires, as a rule, basic skills in metal-working and the like, and normally also requires bringing the equipment to the main shop or a prepared overhaul area, maintenance men handling this class of work are largely kept on it alone, though certain men occasionally may be sent into the mine or pit to handle certain face or field jobs. The number of men and the specialties involved again depend upon the situation at the particular operation or company.

Spare Equipment

PURPOSES:

1. Reducing the effects of breakdowns.

2. Permitting overhauls without production drops.

ONE METHOD OF ALLEVIATING the effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits. It is manifestly impracticable, for example, to buy two 30-yd shovels, one to substitute for the other when it breaks down. The goal here must necessarily be one of making sure that breakdowns are kept to the absolute minimum, and that the shovel be maintained in such condition that major overhauls are required only at rather long intervals.

With smaller units, such as underground loading machines, a much-greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment—and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spare-unit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections, and transferring the crews for the overhaul period, on the basis that moving men is less costly than moving equipment.

Standardization

PURPOSE: Simplification of maintenance work, with consequent increase in efficiency, through keeping the types of units to be serviced to a minimum.

STANDARDIZATION OF MINING equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantages of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Personnel Training

PURPOSES:

1. Instilling a regard for maintenance principles in supervisors and operators, thus reducing machine abuse and stimulating inspection and reporting of potential difficulties.

2. Increasing the skills and knowledge of the maintenance men themselves, with resultant increase in their effectiveness.

TRAINING IS USED here in the broad sense of developing both a regard for the value of maintenance and a knowledge of basic principles, in addition to specific work designed to increase the skills of the maintenance men themselves.

Operating Managers and Supervisors—While they need not, perhaps, be required to take formal courses, particularly in the details of maintenance, operating managers and supervisors should know what good maintenance means and how to go about getting it—and also keeping it.

An example of a program conducted by the company itself is detailed in the September, 1955, issue of *Coal Age*, p 68. The emphasis is on the electrical side of maintenance; and training facilities include actual

trouble-shooting methods on motors and controllers, as well as special wiring diagrams for use in the classroom and underground. The training is done by the electrical engineer, and includes examinations to ascertain progress in learning.

Operators—Here, again, formal courses may be impractical, but since a careless or uninformed operator can raise delay time and maintenance costs significantly, he also should be made aware of what good operating practices mean in both high production and low cost, and of what he can do to prevent machine delays and breakdowns. The logical men to provide him with the necessary information and skill are the foremen and the section or field mechanic or electricians.

Maintenance Men—At least two types of skills are necessary in achieving maximum results in maintenance, repair and overhaul. One type is the basic skill, such as, machining or welding. Three ways of obtaining men with such skills are: (1) hiring men already proficient, (2) hiring graduates of training courses, and (3) setting up company training programs, either conducted on company premises by company-employed trainers, or by outside training establishments to which the employees are sent.

A second skill is proficiency in diagnosing and taking care of trouble on specific equipment units, where a good knowledge of what the unit is and how it operates is imperative. If this skill is not already available, or if it is felt that it could be upgraded, sources of training include:

1. Factory instruction, either at the manufacturing plant itself or through service representatives visiting the mine.
2. Extension courses made available by colleges and universities.
3. Trade-school courses.

Even if only a basic knowledge of electrical and hydraulic principles was gained, the extra insight should result in a better electrician or mechanic, especially if it resulted in his taking more of an interest in his work because it was more meaningful to him.

Contract Maintenance

SINCE OUTSIDE SHOPS serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especially to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are set up to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, and bulldozers, small shovels, engines and similar equipment for strip mines; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Rated Voltage

PURPOSE: Preventing motor failures and cable damage by preventing excessive heating as a result of the excessive current which accompanies low voltage.

IT IS DIFFICULT to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increases, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F or higher, at which point it will burn even if nothing else fails before.

As an example of what can happen, consider a 50-hp motor, 0.85 efficiency, served by a 1/0 cable 300 ft long and trying to do the same work at 270 and 180 v. The extra current loss in the conductors at 180 v could approximate 0.4 kw. On this basis, the extra heat generated in 1 hr is equivalent to between 6 and 7 lb of coal. It is almost the equivalent of operating a household stoker inside a jacket of cable or motor insulation.

Maintaining Voltage

Admittedly, the preceding is an extreme case, although not unknown in actual operation, where heat has been known to cause trailing cables to almost explode into flame. It points up, however, the need for maintaining rated voltage at machine terminals, especially in view of the higher horsepowers being crowded into motors used on face machines, and into others as well.

The causes of low voltage include:

1. Substations too far from the working face (see article on electric power beginning on page 70 of this issue for recommendations on maximum distances).
2. Excessive cable length.
3. Inadequate feeder and return capacity.
4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles, decreasing cable rating because of inadequate air circulation.
2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should always be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as, asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

Cable Maintenance

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and over-

load, the major causes of cable failure, particularly underground, are:

1. Excessive Tension—Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.

2. Mechanical Damage—Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

Additional data on failures and their causes appears in a comprehensive discussion of cable types and cable maintenance in the December, 1953, issue of *Coal Age*.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically in the section (*Coal Age*, January, 1951, p 70). A fairly common failure in trying to keep a cable with too many splices or otherwise in less than topgrade condition in service. The cost of the delays in some instances will repay the cost of a new one in as little as 2 to 4 days.

2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

Temporary splices should be kept to a minimum. One rule allows six, after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices. At certain operations where attendants are required at substations or other facilities, these men are provided with the necessary repair and vulcanizing facilities and take care of splicing, vulcanizing and other cable maintenance, thus saving the wages of a repair specialist.

Fault-Finding—Failures in long high-voltage cables, such as on strip shovels, can result in a long search for the trouble point, with attendant loss in production time. Electrical fault-finders now on the market cut this time loss to a minimum by giving a quick and accurate indication of where the failure occurred. Or, the mine can make its own (*Coal Age*, May, 1953, p 108).

Lubrication

PURPOSE: Providing at the right time, in the right place, and in the right quantity the proper lubricant necessary to provide the thin film that prevents bearing wear and consequent machine breakdown.

Responsibility

Attainment of efficient lubrication requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment. This responsibility normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer—at least where a company operates several mines and a large number of producing units. Sources of help in lubricant selection include lubricant suppliers and the engineers of the machine builders.

2. Establishment of a lubricating schedule. Scheduling, with attendant reports and records, is perhaps one of the most-vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

Lubricant Application

The third responsibility in lubrication is getting the job done, which responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section or pit mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand Lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

Hand lubrication involves more transfers and containers, as a rule, and makes for more complicated distribution in addition to increasing the risk of contamination. In view of this, one company (*Coal Age*, May, 1956, p 68) maintains central storage tanks (in old mine cars) at central points in working sections. The tank is filled from a large oil car by the supply crew, and is pumped through a hose to a convenient point near the face units.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground and at strip pits. Hand lubrication may be desirable for several reasons, including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is employed, the offtrack equipment may be brought to the loading station once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

As for results, one mine bought a truck to serve eight loaders and nine cutters, and in the first 18 mo of use had only three bearing failures. Lubricant consumption was reduced 65% in the same period. Another mine using a truck reports that a loader can be greased completely in 10 min.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, four lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum man-

SHOVEL NO. ______ **SMALL SHOVEL LUBRICATION RECORD** MONTH OF______19

DAY OF MONTH	1	2	3	4	12	13	14	15
AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT. IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN — SHIFT	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm
HOURS OR MINUTES DEADHEADING								
HOURS OPERATED LOADING COAL, ORE, ETC.								
PARTS LUBRICATED — PIT NO.								
(1) Truck Frame and Propelling Machinery (Lower Works)								
All Fittings Below Deck Lubricated								
Circle Rollers Lubricated								
All Cat Assembly Fittings Lubricated								
Propel Bearings Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
(2) Revolving Frame and Machinery Units (Upper Works)								
All Fittings in House Lubricated								
All Open Gears Lubricated								
Enclosed Gear Case Oil Level Checked								
Hydraulic Oil Level Checked								
Gasoline or Diesel Engine Oil Changed								
Light Plant Oil Changed								
Electric Motors and Generator Bearings Lubricated								
Flexible Couplings Lubricated								
Air Compressor Oil Changed								
Air Filters Cleaned								
(3) Front End Equipment								
All Boom Fittings Lubricated								
Boom Support Cables Lubricated								
Hoist Cables Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
All Bucket Fittings Lubricated								

(1) TRUCK FRAME AND PROPELLING MACHINERY

PARTS TO BE LUBRICATED:
Drive Tumbler Shaft and Transverse Propel Shaft Bushings.
Longitudinal Propel Shaft and Propel Brake Shaft Bushings.
Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump)
Center Pintle Bearing Bushing.
Take-Up and Idler Tumbler Bushings.
Steering Clutch Shifter Collars.
Steering Clutch Sliding Jaw Guide Bars.
Propelling Bevel Gear Cases.
Cat Side Frame Gear Cases
Swing Rack Teeth
Roller Track Bars.
Roller Pins.

(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works)

PARTS TO BE LUBRICATED:
Vertical Propel Shaft and Upper Propel Shaft Bushings.
Propel Bevel Gears and Sliding Propel Gears.
Hoist Pinion Sleeve Bushings.
Hoist Gear.
Drum Shaft Bearings
Intermediate Shaft Bearings
Intermediate Reduction Gear Case.
Vertical Swing Machinery Gear Case.
Vertical Swing Shaft Lower Bushing
Electric Motors and Generators
Hydraulic Pressure System
Operating Lever Shaft Bearings, Bell Cranks.

(3) FRONT END EQUIPMENT

PARTS TO BE LUBRICATED:
Boom Point Sheave Bushings.
Shipper Shaft Bushings.
Saddle Block Bushings
Dipper Handle and Saddle Block Slide Plates.
Shipper Shaft Gear Case.
Intermediate Gear Case.
Intermediate Shaft Bearings.
Dipper Padlock Sheave
Dipper Door Hinge Pins, Padlock Pins, Ball and Handle Pins
Wire Ropes

PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
Point Sheaves Crowd Fittings	3 times per shift 3 times per shift	1. Start of shift 2. Two hours after starting 3. At lunch time
Fittings in House	2 times per shift	1. Start of shift 2. Middle of shift
Circle Rollers	1 time per shift	1. Start of shift
Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift 2. Two hours after starting 3. After lunch time
	Dry Pit Conditions 2 times per shift	1. Start of shift 2. After lunch time
	Deadheading Every 1,000 feet	1. Start before deadheading
Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift 2. Lunch time
	Deadheading As often as dry spots appear, or approximately every 1,000 feet	
Hoist Cables	Every 24 operating hours, Never let hoist drum cable grooves run dry.	When convenient When dry
Boom Support Cables	Once a month	While machine is idle.
Enclosed Gear Cases	Check oil level once a shift	Start of shift
Hydraulic System	Check oil level once a shift	Start of shift
Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES: Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.
Shovel operator, pit or loading foremen will be held responsible for checking lubrication work done during their shift, also the keeping of monthly lubrication record chart on shovel up to date.
Pit or loading foremen and operator are to sign record chart at end of their respective shift.
It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times.

Inspections of mechanical and lubrication conditions of shovel will be made by maintenance supervision and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS

- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels.

power and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil—more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers. Applications of centralized automatic systems include:

1. Loaders, cutters, continuous miners and shuttle cars underground. In some instances, the systems are designed to give the bearings a shot whenever the machine hydraulic system goes through a cycle, thus requiring no manual attention whatever. Some, however, prefer to leave start

of the lubricating cycle to the operator because with automatic initiation there is the possibility of overlubricating, with grease getting into, for example, motor windings.

2. All bearings in preparation plans, with the possible exception of motors. Automatic systems, in fact, have included dispensing of grease to underwater bearings on sludge conveyors.

3. Heavy-duty off-highway trucks, including wheel and steering bearings. For a description of how it is done at one operation, with substantial savings in truck time, lubricants and replacement parts, see *Coal Age*, August 1955, p 60.

4. Large stripping shovels and draglines, and possibly other smaller units. One company divides between hand and automatic lubrication of stripping equipment on the bases of (a) cost of special lubricating equipment v. the type of machine and its expected life, and (b) the fact that in many instances the man still would be necessary. Other major factors in this company's program (*Coal Age*, January, 1952, p 76) include lubricant standardization, detailed scheduling of lubricant application, reports on lubricant application, and prevention of contamination.

Results reflect (1) a reduction in the cost of lubricating materials—from 3.05c per ton in 1944 to 2.20c in 1950, in spite of increases in material cost, (2) a reduction in maintenance expense, and (3) a reduction in the losses in production time. The program includes both pit and preparation equipment, and at that time the reduction in cost of maintaining stripping equipment was estimated at $75,000 a year, and of maintaining a dry preparation plant (centralized lubrication), $20,000 a year.

Seals and Fittings

Effective lubrication, in addition to all the other factors involved, depends upon (1) the lubricant getting into the bearing, and (2) the lubricant staying in the bearing. Therefore, fittings, oilers, grease cups and the like must be of the proper type and must be in condition to function as needed. Otherwise, no lubricant. A No. 1 job of any men handling lubrication therefore is to check to make sure the fittings and lubricators are in operating condition, and to report promptly if they are not.

Bearing seals are unglamorous but nevertheless are vital to make sure that the lubricant is retained so that it is available for the job it is called upon to perform. The best in seals therefore is a necessity, and they should be checked thoroughly and frequently, and replaced when necessary. Among other things, this reduces loss of lubricant.

Scheduling

An efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similarly, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground. In any event, the goal is to have something definite and thus avoid hit-or-miss application, buckpassing and the like.

Reports and Records

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Quite frequently, as noted in the previous section, the lubrication schedule and the report can be combined into one document. An example illustrated is a combined schedule and report for a small stripping shovel lubricated by hand.

Lubricant Selection

The recommendation of the equipment manufacturer are the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, provided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on specification rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns. The latter, for example, comes into consideration when gear oils, for example, are being specified. Use of the extreme-pressure type covers all applications with a quality product and eliminates the chance of misapplication in lubricating the operating units.

Standardization—Too many types of oils or greases lead to confusion, misapplication, contamination and loss. Careful study of the lubricating problem will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available include many with the necessary spread in characteristics fitting them to several applications.

As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows:

	Types Before	Types After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease	5	1
Plain-bearing grease		1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

On-the-Job Supplies

PURPOSE: Keeping delays to a minimum by having the necessary parts in or close to the working section or pit face.

IF A PART IS not close at hand, what might be only a minor breakdown can turn into a major stoppage if the item, such as a chain link or hydraulic hose, is missing, requiring a special trip to the supply house or the main shop. Limiting down time therefore requires keeping an adequate stock of the smaller, frequently used items in the section or pit, where they are readily available for the mechanic or electrician. Where heavier, less frequently used parts or critical assemblies are involved, one or more can be kept at a central location, perhaps on a truck or carrier, but still handier to the working sections or pit than in the main supply house or shop.

To prevent loss or damage, section parts should be kept in a supply cabinet, a parts box, or in lockers, drawer's, etc., in the foreman's or repairman's shanty or office. Some mines also have found it advisable to keep certain special tools with the parts so that they are handy when needed. Lamps or other heating facilities should be provided for parts subject to damage by moisture.

Mobile Repair Units

PURPOSE: Reduction of breakdown loss by getting men, tools and materials to the scene quickly; also more effective use of time and wages.

THE REPAIRMAN'S JEEP, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks—gas and electric—where there is an opportunity to use such equipment in fresh air.

Skid-mounted "maintenance centers" (*Coal Age*, September, 1955, p 78, and this issue, p 00) are among the newer types of mobile repair units. Designed particularly for trackless mining and moved by hitching it to a shuttle cars, the centers consist of 4 x 5 x 12-ft steel tanks with flat tops providing bench surfaces for work. Among other advantages, a supply of spare parts is always within 100 ft of the face.

For bringing machines to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

Where pullers are not available, several tricks may be employed to move disabled machines—for example, a drill motor with an adapter to power the crawlers on a loader for short moves.

Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

The number and variety of units reflects the fact that this is a very large operation. At a smaller strip plant, this number and variety would not be practical, but a welding truck plus a general repair truck, or one truck for both purposes, represents possibly the minimum of mobile units.

Communication

If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units such as in the superintendent's car, the repair foreman's car or truck, and the cabs of the key stripping units. A good telephone or trolleyphone system yields the same results in deep mines.

Mine Shops

ALTHOUGH A FEW DEEP MINES make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs, replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

Shop Location

Deep Mines—Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exist, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops—and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

Certain types of maintenance work, such as cable repair, may be done in small specialty shops set up at substations or other points where attendants are necessary to take advantage of what otherwise would be idle time.

Strip Mines—Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops.

Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field, and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

Specialty shops employed by some stripping organizations include a portable welding shop, fabricated from corrugated steel, and mounted on wheels, and large enough to go over a truck or other unit. This facilitates body and other repairs where the unit cannot readily be brought into the shop without dismantling.

Shop Facilities

Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. One shop of this type, located near the bottom of the hoisting shaft, includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts, a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall.

Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

A similar range in scope of work and facilities installed prevails at strip-mining operations, although with these the tendency is to make the mine shop into the main shop.

In-Plant Facilities

Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

Overhaul Scheduling

FIVE OF THE STANDARDS for determining when overhauling is necessary are:

1. Elapsed time—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.

2. Operating time—in hours or days.

3. Tonnage or yardage handled.

4. Inspection.

5. Personal judgment.

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul at one time.

A sixth system is, in effect, no overhaul—or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

What might be called a seventh system is practiced at at least one mine where the coal is low, belts are employed, and the difficulty of handling a major breakdown is much greater than in thicker coal. At this operation, each new panel is started with equipment that has been completely overhauled, the crew merely transferring from a worked-out panel and leaving the machines to the maintenance force.

Main Shops

MAIN SHOPS generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also, in some instances, include facilities for manufacturing repair parts and even complete equipment units, such as, for example, pumps and shaker pans.

Central Units

Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the main shop without increasing overall expenditure.

2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.

3. An opportunity for increasing efficiency because of the greater volume of work in one place.

4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

Shop Types

Main shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Examples are: conveyor-belt shops, cable shops, garage and truck-repair shops, wheel-reclamation and welding shops, truck-tire shops, minecar shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

Shop Layout

Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

Strip-Mine Service Center—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next, a 59x32-ft warehouse; and completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra engines, and some heavy spare parts, including some rear ends and transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small; horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists. Work done includes building dipper sticks 63 ft long or more.

Equipment serviced includes a stripping shovel, loading shovel, two small draglines, 13 semitrailers, 14 tractors, two winch trucks, two bulldozers and two road patrols.

Deep-Mine Central Shop—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions and equipment are:

Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20-ft room.

Four portable cranes handle equipment in all three buildings. Two are 5-ton gasoline-powered units and two of them are 500- to 1,000-lb hydraulic push cranes.

Deep and Strip Shop—Though designed primarily for the complete rebuilding of underground equipment, one shop also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

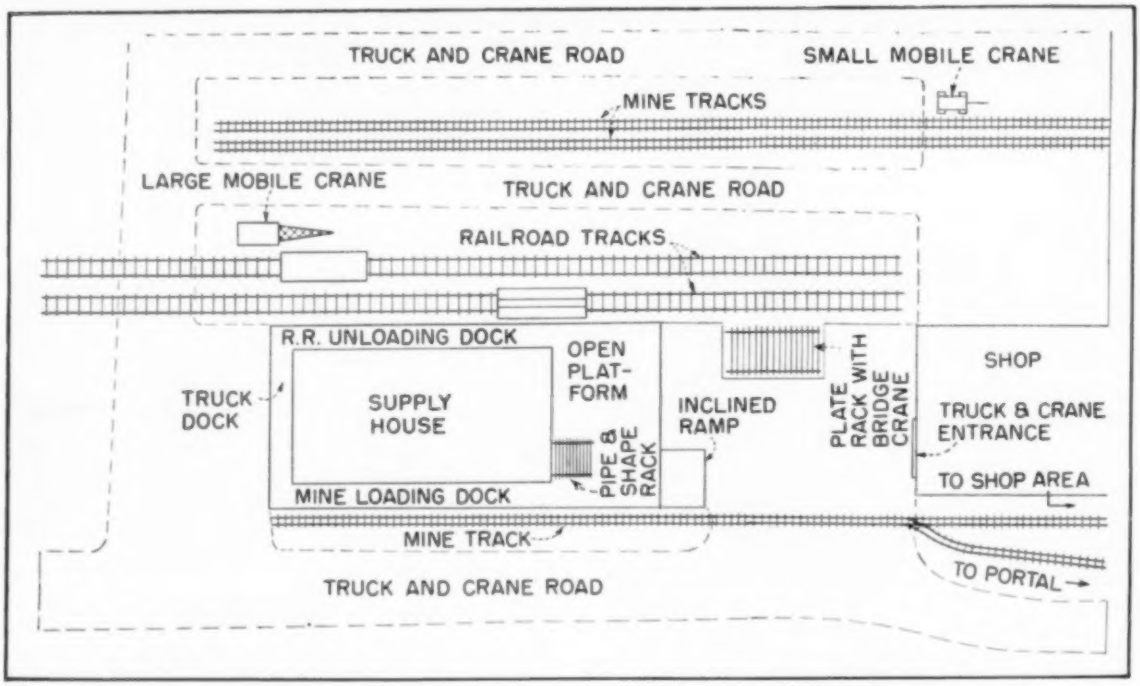
While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and moving anything heavy, including such things as shafts into lathes, and power-operated tools—impact wrenches, etc. Cleaning and degreasing equipment contributes greatly to comfort and efficiency in repair work.

Maintenance Materials

HARDSURFACING PRODUCTS are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.
2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening.
3. Special alloys, bronze, rubber and other corrosion- and abrasion-resisting materials for pumps, valves, fittings and other equipment handling water and water with various solids.
4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.
5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.
6. Rubber, tile, sprayed and sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist abrasion and corrosion.
7. Glass, stainless steel and other wear-resisting materials for chutes, conveyor bottoms and similar applications.
8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.
9. Protective coatings and paint.
10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.



CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation. Accompanying supply house has receiving and loading docks on three sides.

The Supply Guidebook

COAL MINES spend an average of approximately 85c per ton for operating supplies and materials including repair parts. The low, usually at the smaller operations, is as little as 40c per ton or less and the high is over $1. Surveys by *Coal Age* indicate that the more-efficient operations tend to have supply costs at or above the average, reflecting the fact that keeping machines and men working requires an adequate flow of parts and materials. In other words, a good supply setup promotes efficiency and low cost in four major ways:

1. It enables machines and men to produce more by preventing interruptions resulting from lack of parts and materials—or delays in delivering them to the point of need.

2. It keeps investment in parts and materials to a minimum.

3. It prevents waste and loss of parts and materials.

4. It insures that parts and materials are received, stored and delivered to the point of use at minimum cost.

What is involved in a good supply setup and how to get it are the subjects of the material which follows in this Supply Guidebook.

Inventory Control

PURPOSE: Keeping investment in parts and materials on hand to the minimum consonant with efficient mine operation.

TOO HIGH a supply inventory means letting money lie idle, while too low an inventory can mean production delays and higher production costs. Depending upon mine location and other factors discussed in the following, the level of supplies at individual mines ranges from as little as $25 to $30 per ton of daily capacity up to $150 or more per ton at mines remote from manufacturing and distributing centers. The average appears to be in the neighborhood of $50 to $60 on hand per ton of daily capacity.

Under coal-mining conditions, the inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

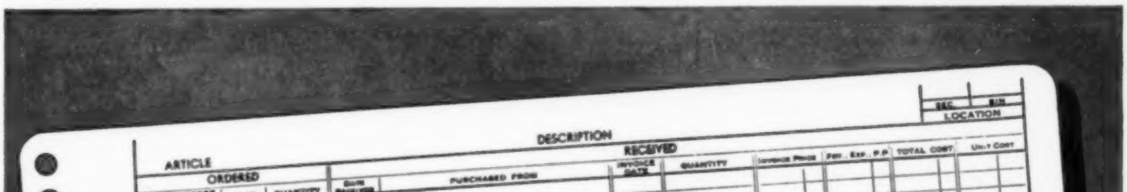
1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for non-productive labor, for power for ventilation and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

In all these, it is assumed that the tonnage loss could be made up at a later date and that the extra cost on the breakdown day is the major factor, though if the breakdown occurred near the end of the shift the loss might be reduced by better preparation in the mine for the following shift and consequently a higher tonnage and higher efficiency on that shift.

From the preceding, it can be concluded that there is no easy sure-fire formula for relating parts inventory to breakdown losses, though there is, of course, at least an approximate relation. Careful study of the problem is the best guide to informed judgment of what is needed.

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. However, it may be considered desirable to have an additional reserve, which becomes

FLAGS on the bottoms of these perpetual-inventory cards, kept in tray-type files, permit easy checking.



PERPETUAL-INVENTORY SYSTEM provides a running record of supply receipts, disbursements and costs. Cards shown here are for loose-leaf ledgers (above) and tray-type files.

largely a matter of judgment. Or, the total use in, say, 6 mo, might be so small that it would pay to keep that much stock on hand to avoid the extra clerical and other effort involved in ordering more frequently. Also discounts for volume may be a factor in quantity ordered and consequently the total on hand at any one time.

3. Central warehousing vs. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

A major advantage of the central system is reduction in total inventory because it is not necessary to duplicate each item at each mine, particularly the larger, more-costly units, since, with fast delivery, a small number of, say, armatures can serve the several mines. Otherwise, it might be considered necessary to keep one at each property.

Exceptions, of course, include, as noted, timber, ties, roof bolts and other items used regularly and at relatively fixed rates which, once the rate of procurement and method are fixed, should be delivered directly to the mines to save rehandling.

4. Cooperative stocking. Where a part or a component is large, costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed. Thus, several companies—for example, a group of strippers using identical machines—are protected against major production losses with a minimum outlay for spare parts of a key and costly nature.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases. A more-rare occasion for perhaps increasing inventory is anticipation of decreased availability as a result of strikes, government control of critical materials, and so on.

Control Systems

PURPOSE: Accurate records of quantities on hand, quantities issued and dates of reorder.

WHILE THE PLURAL "systems" is used in the title to this section, coal mines have largely settled on the "perpetual" system of inventory control. Basically, this system shows quantity and cost of units and materials received, quantity and cost of units and materials issued, and quantity remaining on hand at all times. From this, it gets its name "perpetual."

Two of the methods of keeping a perpetual inventory are:

1. Cards on each bin, particularly of the smaller items, on which the records of receipt, disbursement and quantity on hand are kept.

2. Cards designed for keeping in tray-type files, so-called rotary files, or in loose-leaf ledgers.

Wide use of the file-card system indicates that it is the handiest and surest. With bin cards or other systems, it normally is necessary to make an inspection or separate notes as the parts and materials are issued to determine if reordering is necessary, and those who have used the bin-card system report that there is a greater possibility of running short through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both show purchases, including, in one type, cost of shipping, and both show cost and quantity received, cost and quantity issued and cost and quantity left on hand after each disbursement. The ledger form also includes a column for the account number to which the supplies are charged. Both also indicate warehouse section and bin number where the item can be found.

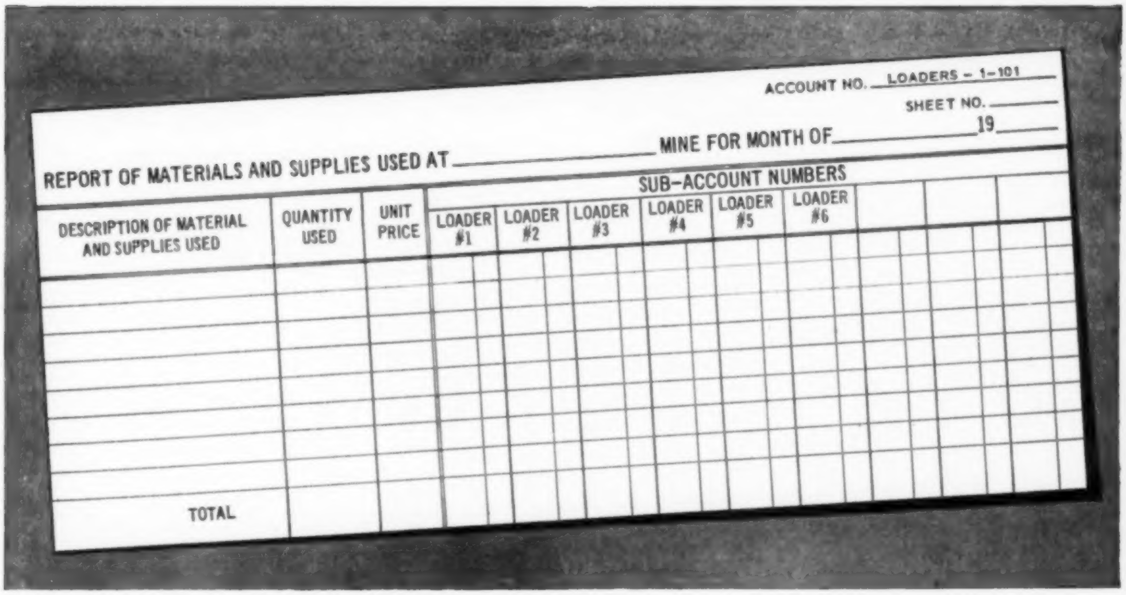
The perpetual system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. In some instances, certain types of supplies, such as timber when bought locally as offered, may be excluded from the perpetual system. However, when there are exclusions, it becomes the responsibility of some supervisor or employee to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data are supplied for the periodic supply-use and inventory reports. Most mines prefer to have everything in the system.

The records used in the perpetual systems also provide a convenient means of determining when reordering must be done. In other words, when the quantity left on hand after the last disbursement reaches a minimum shown by experience, a new order is placed. By the same token, the records may be used to prevent overbuying by establishing a top limit on quantity on hand, and also for maintaining an approximate average level between the minimum and maximum.

Certain types of cards are designed to permit the use of "flags," or colored tabs, to facilitate reordering and the compilation of periodic reports on use of parts, supplies and materials. A green plastic tab on the bottom of the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next weekly requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card for either preparation of the distribution report, or for reordering, thus saving considerable time and making it easier for the supply clerk.

Whatever the control system employed, it should be supplemented by an actual physical inventory. The practice varies between 6 mo and a year at most mines.

Even at small operations, an accurate record of receipts, cost and use is essential for wise and economical use of supplies, and while the perpetual or other good inventory system re-


ACCOUNT NO. LOADERS – 1-101
SHEET NO.
19
REPORT OF MATERIALS AND SUPPLIES USED AT ________ MINE FOR MONTH OF ________

DESCRIPTION OF MATERIAL AND SUPPLIES USED	QUANTITY USED	UNIT PRICE	SUB-ACCOUNT NUMBERS								
			LOADER #1	LOADER #2	LOADER #3	LOADER #4	LOADER #5	LOADER #6			
TOTAL											

MONTHLY USE REPORTS such as this lend themselves to summaries by account or function numbers, or by individual units. Here it provides a means of keeping track of parts costs by individual loading machines.

quires some paper work and the assumption of responsibility by some person, it can save both money and production time in the same proportion as in the larger operations.

Use Records

PURPOSE: Accurate determination of the cost of parts and supplies by functions or, in more detail, by machine and section, as a means of checking on loss, waste and destruction through carelessness, machine abuse, and so on.

THOUGH IT REQUIRES extra paper work, there is a growing tendency to go beyond the standard "supply-distribution report" and require more detailed reports on use of parts and materials by machine and by working section for the purposes listed in the preceding paragraph. The standard distribution report, usually prepared monthly, shows supplies charged to classes of equipment, such as, shuttle cars, and to mining functions, such as ventilation, timbering and the like. For convenience, each equipment class or mining function is provided with an account number.

Where account numbers are used, some hold that the daily or other delay reports (see the Maintenance Guidebook in this issue) provide—at least by inference—sufficient information to determine whether supplies are being used properly and economically. Those who are adopting the more-detailed system argue that definite and positive information is a necessity to prevent waste and loss through abuse and carelessness, particularly in view of the rising cost of everything that enters into mining.

Whatever the system, order forms, reports and records are essential for the proper evaluation of supply use. To start off with, nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. This applies even if the item is for current use, such as, timber, or is to go into, say, a section parts depot to replace some item used in maintenance. And for a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

The monthly distribution report previously referred to and prepared by account number is one form of report to mine and operating management. Where more detailed data are desired, the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, such as pumping, thus providing a better opportunity for determining whether abuse is running up parts cost for a particular loading machine, as an example, or whether certain sections are taking a larger-than-normal supply of timbers, perhaps indicating waste.

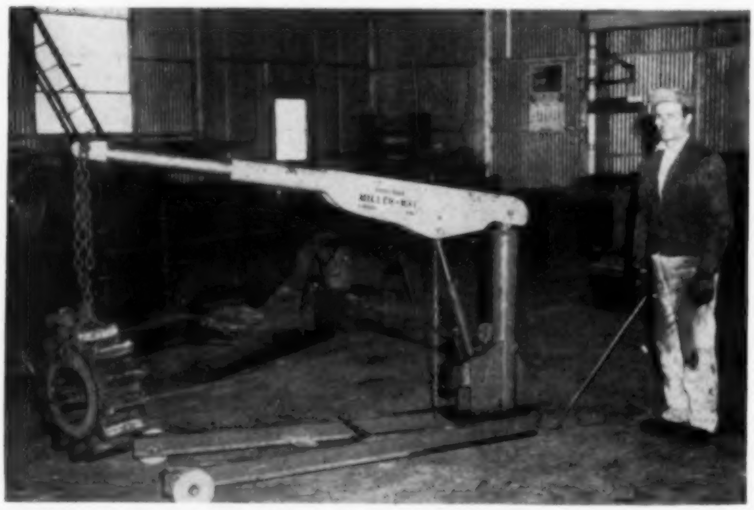
Aside from reports derived from the regular requisitions, special reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more, and, therefore, some operators feel that it is in order to ask the section foreman or machineman to report daily on number on hand at the start of the shift, number received for replacement, number sent out for grinding, number destroyed in operation, and number on hand at the end of the shift. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties and the like.

Since they are required to report on use, the men responsible naturally would take care to prevent loss, and if the record showed excessive destruction, for example, there would be an opportunity to check to find out why. Incidentally, such records also would reduce the number of small items, such as, cutter and drill bits, that would find their way into the railroad cars, particularly if the responsible men were required to turn in the worn-out or broken items.

To wrap up a detailed record system, it naturally should show transfer of certain materials, such as, steel ties, from one working area to another, thus guarding against, among other things, possible loss through carelessness or buck-passing. And if such things as timber were salvaged for use elsewhere, the records should show how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.

Naturally, records of this type are valuable only if the information de-

MOBILE CRANE with various attachments, including clamshell and timber fork shown here, handles heavy materials in the supply yard and can unload a car of ties in less than 1½ hr.



PUSH-TYPE LIFT TRUCK eases problem of handling heavy parts and units in supply house and shop. The units also may be motorized.

rived is made available to the proper officials—hence the need for the distribution reports previously noted.

Allocation of Stocks

PURPOSE: Preventing production interruptions by providing stocks of parts and materials at or near the point of use.

EVEN WHERE ONLY ONE mine is involved, the satellite principle of stock allocation is necessary to keep production interruptions to a minimum. In other words, stocks of frequently used machine parts, as an example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic. Otherwise, major delays may occur as a result of having to send outside or to the main supply house for a needed item.

Type of unit and experience indicate the types of parts and materials to be kept in such satellite pit or face depots. Normally, replacements for such stocks are charged to operating cost when they leave the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report (see the Maintenance Guidebook) can show what items are used and where.

Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

There are, of course, many modifications of the preceding systems to suit individual conditions. The goal in all should be, however, providing adequate stock at points of need whatever the system employed.

Storage and Handling

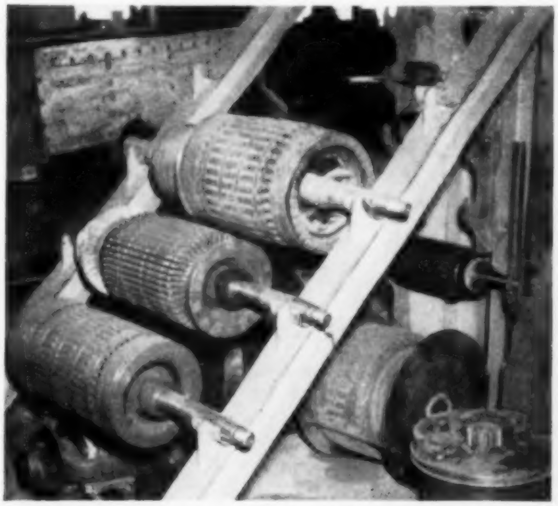
PURPOSE: Protection as necessary, and receipt, storing and issuance with a minimum of labor.

TYPE, SIZE AND COST of specific items normally dictate methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply buildings and also sheds for certain items requiring less protection.

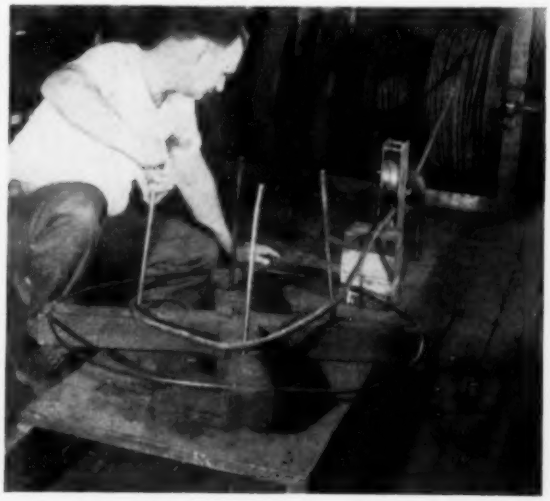
Open or yard storage is satisfactory for timber, steel ties, rail and the like, including heavy equipment items that are not appreciably affected by rust

OIL-HOUSE OPERATION is facilitated by such equipment as these castor-mounted tilting racks.

GRAVITY SAND DISPENSING is facilitated by boreholes or, as here, bin over the drift portal.



SPECIAL RACKS accommodate spare armatures and provide protection until put into service.



REELS FOR CABLE and similar materials facilitate storing, handling and measuring out pieces.

and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe, structural shapes, plate and the like to prevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the ability to use such equipment may outweigh the disadvantages of open storage.

Storage Layout

While the storage layout will vary from mine to mine, the plan shown at the start of this Supply Guidebook illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required. The principles illustrated include:

1. Receiving and loading dock completely surrounding the warehouse. This is a practice that can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

The design permits running hand trucks or other mobile equipment directly into cars or trucks in most instances for unloading, and also permits lowering items directly into mine equipment. It will be noted that for the most part items are taken into the supply house from one side and then moved directly across to the mine track. If desired, the truck dock may be reduced to one-truck width, extended inside the supply house, and equipped with rollup doors so that loading and unloading can be done completely out of the weather. The railroad unloading and mine loading docks also may be roofed if desired, but here again a roof may prevent the use of mobile equipment for handling heavy items.

2. Open storage planned so that as heavy material is unloaded it can be

STORAGE-IN-TRANSIT FACILITIES include these rubber-tired explosives trucks at a stripping operation.

VERSATILE FLAT-BED TRUCKS facilitate supply delivery. Diesel locomotives are finding wider use in yards.

placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling unit materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example, two men can unload a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

OVERHEAD ELIMINATION—Added flexibility is achieved in the yard illustrated by the complete elimination of trolley wires—a growing trend in the design and operation of supply yards. Elimination of wires also eliminates a hazard, which still is present even if continuous guards are installed. Without trolley wires, material can be stored and reclaimed from either side of the mine track, and high-lift mobile cranes can handle materials across one or even two tracks without difficulty. Cars are handled in such yards by battery locomotives or, more commonly, by locomotives powered by gasoline or diesel engines.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage. The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.

As noted, there are many variations in layout to suit individual mine conditions. Among them are incorporating the supply house into a larger structure serving, for example, a truck garage and repair depot on one side, and a machine shop and general repair shop on the other. Or the supply house may parallel the shop with a track in front of the doors to the shop for loading parts and materials into the mine equipment brought in, say by a diesel or battery locomotive. Thus, most of the loading equipment is under cover.

Supply-House Facilities

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a monorail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawer-type and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc.; peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eyesight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which give when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

In addition to provisions for hand trucks, some companies have found it desirable to provide aisles wide enough—at least in the areas where heavy units are stored—to permit small push-type mobile cranes or even motorized units to be brought in for moving say, armatures to a neighboring shop or to cars or trucks for mine delivery. This presupposes floor construction strong enough to stand up under the traffic and also floors at ground or loading level, or ramps at convenient points, to permit mobile units to travel in and out from ground or other level.

Special Supply Houses

SUPPLY FACILITIES falling into what might be termed the special class are: powder and oil houses, sand-storage and drying establishments, and even portable or semi-portable pit or mine houses.

Design and location of powder houses is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives. Factors to be considered with other types include:

Oil Houses—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. Oil and grease are, after all, flammable. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramp rails to permit rolling drums up to position, unless chain hoists are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with castors, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

Sand Houses — Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the road up on the hillside so that trucks can dump directly to the bin.

The preceding comments presuppose gravity flow from the wet storage bin to the drying stove or stoves, and from the stoves or dry-sand bins to the locomotives, sand cars or borehole to the mine bottom. This gravity flow materially reduces labor in all phases of receiving, drying and dispensing sand, and this saving may warrant a substantial investment in bins and gravity-handling facilities which, in some instances, are almost or completely automatic.

Though not yet possible in too many mining areas, sand-handling facilities may be eliminated completely by depending upon outside suppliers for drying and delivery. At one operation, the custom drier delivers the sand in oil-type drums ready for movement into the mine.

Portable Supply Houses—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

THE MOTOR TRUCK in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well —fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

Delivery between supply house and shop, for example, where the two are not too far apart and are connected by a hard-surfaced roadway, may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

Borehole Supply—One new wrinkle in speeding up delivery to shops or distribution facilities underground is the supply borehole. One such borehole (*Coal Age*, March 1956, p 94) is fitted with a 24-in casing (large enough for an emergency escapeway) and a headframe with a 5-ton hoist. Spotted at the right place, a borehole sometimes can save a long underground trip for parts and other small items.

Underground Delivery

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be equipped for pulling the equipment on such auxiliary track systems to avoid having to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long crossbars and other items without hazard to men or to the belt and conveyor.

Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.

2. False pan lines, or lines of pans alongside the operating line, which are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded

24-IN BOREHOLE, photographed in snowstorm, cuts time in getting parts underground.

HOME-GROWN CRANE, with extensible boom and crawlers, saves time in handling heavy materials and parts.

with supplies until the place is halfway up, at which point the loaded line will complete the place.

In pitching places, small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

Mobile Units—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted pullers and carriers also have been built for moving drives and for handling materials.

The extra advantages of special equipment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery-powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For rail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes, which lends itself to handling almost any shape or size of material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous track and trolley supplies, coal augers, roof bolts and the like.
2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.
3. Enclosed powder cars with sliding doors and insulated couplers.
4. Special insulated detonator cars with steel doors, wood and rubber lining, and compartmented drawers.
5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or typing the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

Preventing Waste And Loss

THERE IS NO PARTICULARLY easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. Good Records—Where supplies go and how much (see "Use Records").

2. Education—Some companies have found, for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home to men the costs involved in loss or carelessness and consequently leads employees to handle materials and parts more carefully.

3. Prevention of Machine Abuse—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

TRAILER PULLED BY BATTERY TRACTOR solves problem of supply delivery in trackless-mining sections.

4. Rated Voltage—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

5. Protection—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

SUPPLY TRANSFER UNDERGROUND is facilitated by hoist and monorail at one trackless operation.

Salvage

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 of labor to recover something worth only $1 in the first place is, of course, out of the question. However, in view of the cost of materials and supplies these days, a carefully considered salvage program can result in major savings.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benefits not only by the return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chain slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars—as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.

A new trend which shows signs of growing is the formation of special salvage organizations. As an example, one company appointed an experienced mine superintendent as head of salvage, provided him with facilities at a worked-out mine and gave him final authority as to whether a piece of equipment or a part should be rebuilt or finally junked. It expects a substantial saving per ton over the hit-or-miss program previously in force.

SOLID ORGANIZATION assures proper safety education and training of supervisors and employees, using all practical means, including public address systems, and thus creates the climate for advancing on all fronts.

The Safety Guidebook

GREATER SAFETY follows when good planning and zeal are applied to the problem, just as in all other phases of mine management where benefits are expected as a matter of course in proportion to the skill and effort put forth. Assuming that a sincere desire for improved safety exists at top levels and all down the line, the achievement of the goal then becomes a step-by-step process.

If safety promotion can be reduced to anything resembling flowsheet terms, the dominant lines of flow would be somewhat like this:

1. Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.

2. Train and educate for safety, using planned programs for workmen, supervisors and management.

3. Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions leading to accidents.

4. Keep interest alive by a continuous program of safety incentives, any of which may be scrapped without remorse the minute it loses its appeal.

Although safety is its own reward, these four guides will lead to other benefits, such as, higher morale, a stabilized labor force and higher efficiency, which lead in turn to lower costs.

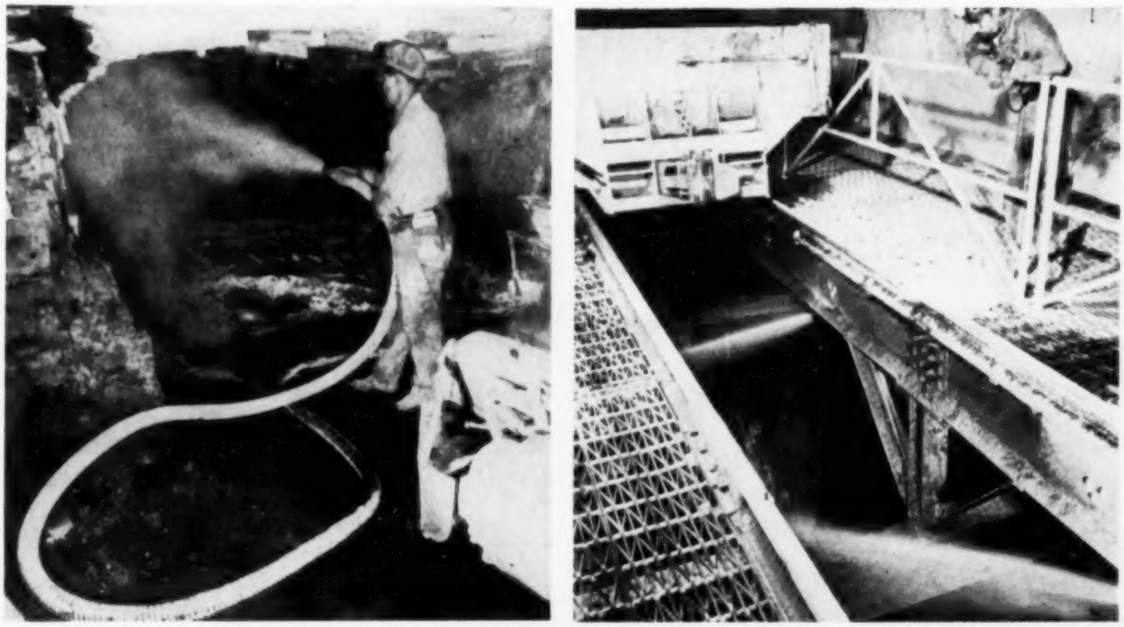
Safety Organization

THE TYPE of organization depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies operating a number of deep and strip mines and cleaning plants the safety department may include one or more qualified men to fulfill each of the functions.

The important requirement is that some provision be made for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may become a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety work.

The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration of the matter. A top-notch safety department is worth the effort because it pays off in better employee and public relations, reduced labor turnover and increased efficiency, in addition to its primary function of accident prevention.

Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and



MAINTENANCE OF PROPERTY in safe condition calls for the use of modern equipment like this rockduster and spray system, in addition to procedures for inspecting, reporting and repairing to keep physical plant free of hazards.

acted upon, their suggestions should be carefully weighed, and their active support in training and promotion ventures should be solicited.

Above the company level a need may exist for an organization to promote safety for a group of mines or companies having similar safety problems. A full description of an organization of this type appears in the September, 1955, issue of *Coal Age*, beginning on p 58 and featuring the highly successful operations of the Indiana Joint Committee for Coal Mine Safety.

Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organization for safety. Of course, cooperation with federal and state safety and inspection authorities is an integral part of any safety effort.

Training and Education

THE TERMS training and education are not synonymous. They are two distinct functions, differing in scope and in emphasis. Safety education is a broad program designed to convince workmen and supervisors of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of a hard-hitting direct attack on particular hazards, like 100% training in accident prevention. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed from sight.

Training Fundamentals

A need for training may be indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause—haulage, for example—may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions, conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials.

Striking examples of the safety benefits to be derived from well-planned training efforts are presented in *Coal Age*, July, 1953, p 100; December, 1953, p 66; and May, 1955, p 93.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

Training, though, is not an end in itself. The clincher is in management's follow-through, making sure the training came off as desired.

SAFETY SUPPLIES should be provided at marked locations throughout the mine.

CLEANLINESS AND GOOD ORDER can be maintained in the interest of safety if care is taken in designing the plant to permit washing down.

Maintaining Physical Plant

VIGILANCE is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys—inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing.

Some larger companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The inspector at the end of his visit leaves at the mine or plant a list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations.

Deep Mines

The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer supervision, strict compliance with timbering standards and bolting patterns, including as much extra support beyond the standard pattern as necessary, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

Efficient ventilation also is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may include wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution, even at today's faster pace.

Wet rock dusting is the latest application method. Goals are not only a good dusting job but also elimination of the dust problem, which can be particularly acute in dusting in cycle behind, say, a continuous miner. Methods and equipment in two mines are outlined in articles in the following issues: *Coal Age*, February, 1955, p 82; January, 1956, p 62.

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

Knocking dust down as it is made by water sprays takes on added importance not only as a means of reducing the explosion hazard but also because of the increased disposition on the part of compensation commissions to grant awards for purported lung damage, even though coal dust still is to be proven as the culprit. For the latest on the question of coal's possible role in lung trouble, see the July, 1956, issue of *Coal Age*, p 56. In any event, prudent management will do its best to keep dust counts below the accepted minimum and supply dust masks when working in high concentrations cannot be avoided.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested firehoses and chemical extinguishers, where needed. First-aid supplies should be provided in clean, well-lighted rooms, and self-rescuers sufficient for the men in the areas should be placed in caches in strategic underground locations.

Stripping

In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wire-rope

changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good condition to head off steering and brake failures particularly. Well-drained smooth-surfaced roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled or treated with dust-allaying chemicals for better visibility.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble near the edges of spoil banks. Safety in the pit distribution of high-voltage electricity must be a primary concern of top management through the chief electrician.

Preparation

In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, clean-up precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equipment; and black and white for traffic lanes and direction signs.

One final requirement, if all this maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

CLEAN EQUIPMENT, clear roadways, good rockdusting, adequate roof support mark top-drawer safety maintenance in underground workings.

IF A SLOGAN CONTEST IS HELD the winning slogan should be plugged for all it's worth, as this Ohio company does with its winners on dipper stick.

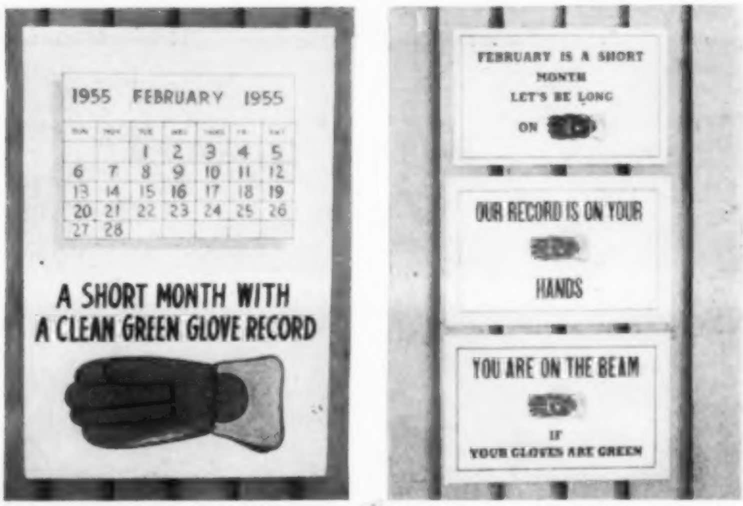
Keeping Interest Alive

ILL-ADVISED INCENTIVES may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

A case in point is the experience at two mines where the supervisor and each workman on an accident-free crew receive a pair of green-colored all-leather work gloves trimmed in yellow each month the record is maintained. Simple, but effective! Frequency rates at the two mines during 1954, the first full year of incentive operation, were 48 and 50%, respectively, below the rates for 1952. An immediate improvement was noted when the program was adopted in August, 1953 (*Coal Age*, June, 1955, p 65).

Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted. One company, for example,



GREEN LEATHER GLOVES are given to safe workers by a West Virginia company which hangs a safety campaign on these eyecatching symbols.

has distributed winning slogans on bumper cards for employees' automobiles and displayed them on the shovel dipper sticks and in other places about the properties.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing accident rates, it must be summarily discarded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of succeeding.

Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this type of training are especially recommended to insure that maximum long-time benefits accrue.

One of the best ways to keep the safety program alive is to look for opportunities to reward individual achievements in safety. The recipients will be happy to have their achievements recognized, and the others will have their interest aroused. Notable individual safety records may be searched out at virtually every mine.

Help in Buying . . .

A COMPLETE CROSS SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in the following pages to round out this 1956 Mining Guidebook issue of *Coal Age*.

This Buying Directory and Buying Information section is designed to help you in three major ways:

1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

3. If you are developing a new idea in production, preparation and safety and want to see what's available for carrying it out . . .

Check the Buying Directory beginning on p 221 of this issue. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type. Trade names also are included in the Buying Directory for convenience in identifying and selecting products.

Consult the manufacturers' advertisements in this issue for information on specific products, materials and services.

Prepare for Profits

with the right preparation plant NOW!

LOOK TO THE LEADER:

for the widest range of coal washers—

for the widest range of drying equipment—

for every engineering skill that makes coal a better fuel

ask

the men who know coal from the ground up

McNALLY PITTSBURG
MANUFACTURERS OF EQUIPMENT TO MAKE COAL A BETTER FUEL

McNally Pittsburg Manufacturing Corporation—Manufacturing Plants: Pittsburg, Kansas • Wellston, Ohio
Engineering and Sales Offices: Pittsburgh • Chicago • Rio de Janeiro • Pittsburg, Kansas • Wellston, Ohio

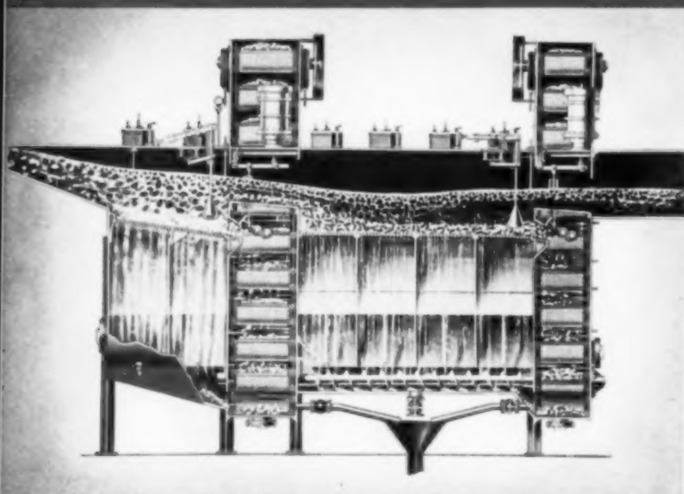
FIRST CLASS
PERMIT No. 93
(Sec. 34.9, P. L. & R.)
PITTSBURG, KANSAS

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

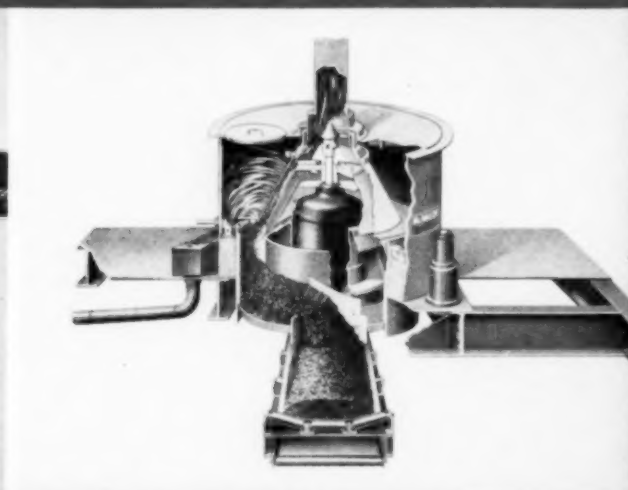
4c-POSTAGE WILL BE PAID BY—
McNally Pittsburg Mfg. Corp.
PITTSBURG, KANSAS

Your mine will earn bigger profits this year — and every year

—if you take advantage of this complete service



WASHING



DRYING

McNally Pittsburg "one-stop service" covers all your preparation requirements —Engineering Service that will give you the greatest returns for your preparation dollar—Manufacturing Facilities geared to deliver you time-tested, efficient Coal Preparation Equipment on schedule.

Whether you require spare parts — a plant addition or a complete new preparation plant, take the initial step to profits and fill in the attached reply card, today—We'll do the rest.

FOR LARGE PLANTS • SMALL PLANTS: YOUR PROBLEMS CAN BE PROPERLY SOLVED FROM AMERICA'S MOST COMPLETE LINE OF OUTSTANDING PREPARATION EQUIPMENT

Gentlemen:

We need complete information on a complete new plant that will wash________inches by 0 at________ tons per hour and dry________inches by 0 at________tons per hour.

We also want information on the following special equipment:

Name________________Title________

Company________________________

City and State____________________

Have Sales Engineer call for further consultation.

G

ask the men who know coal from the ground up

McNALLY PITTSBURG
MANUFACTURERS OF EQUIPMENT TO MAKE COAL A BETTER FUEL

McNally Pittsburg Manufacturing Corporation—Manufacturing Plants: Pittsburg, Kansas • Wellston, Ohio Engineering and Sales Offices: Pittsburgh • Chicago • Rio de Janeiro • Pittsburg, Kansas • Wellston, Ohio

Low alloy, high strength Jalten offers good formability coupled with excellent corrosion and abrasion resistance

Jalten's high strength permits high design loads. It also permits a reduction in section when used to replace mild steels. Usually the reduction amounts to two gages affording a weight savings of approximately 25 per cent. Thus, dead weight can be eliminated—resulting in increased carrying capacity. Also, it is easily welded.

Jalten is furnished in four grades:

No. 1—possesses high strength, good formability and fabricating qualities—good resistance to low temperature impact.

No. 2—offers high strength, moderate formability—improved resistance to atmospheric corrosion.

No. 3—gives high strength—improved resistance to abrasion.

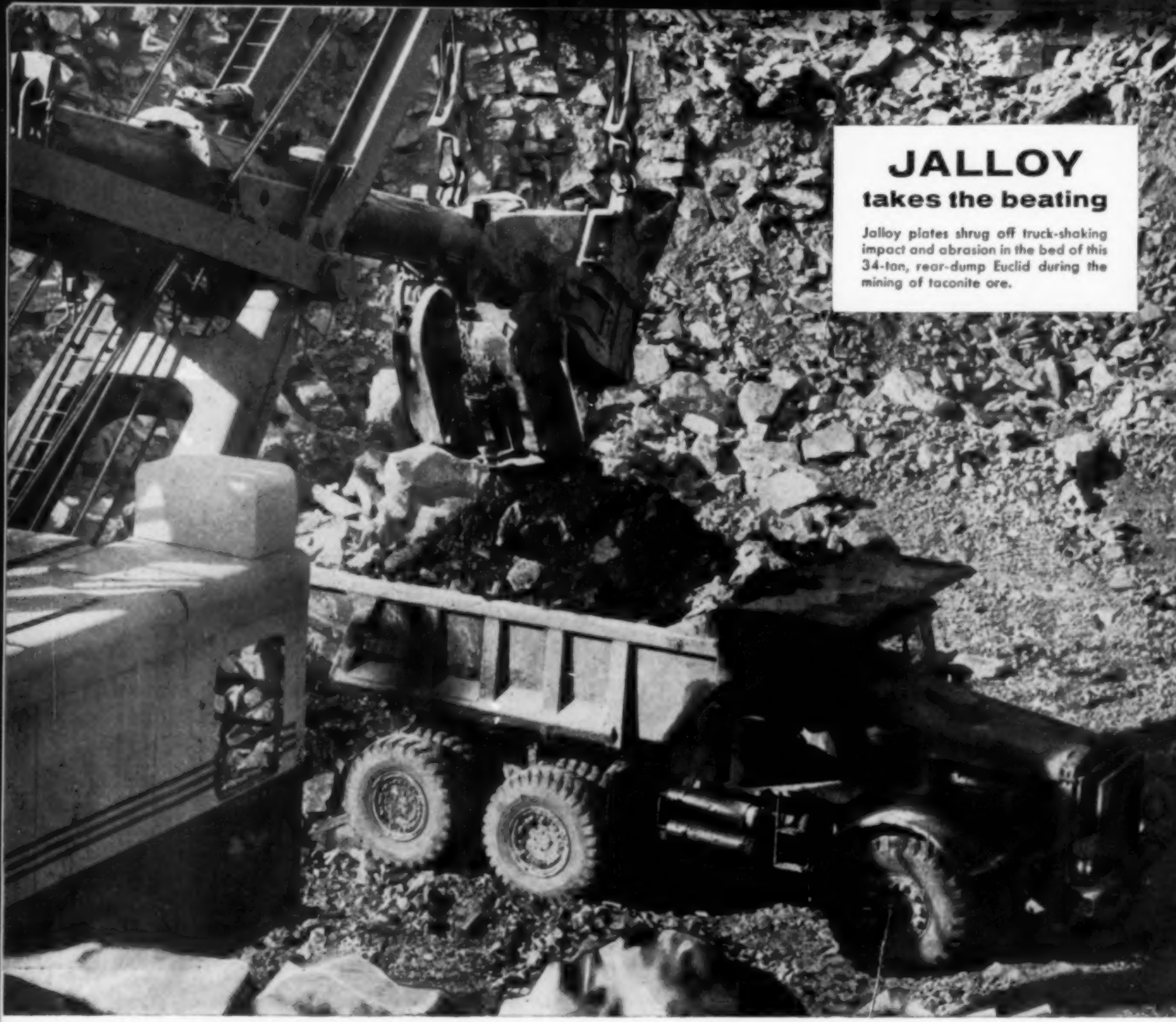
No. 4—provides superior formability and surface quality for bumper stock applications requiring plating.

Jalten Steels are available as sheets, strip, plates, structurals, bars and small shape sections.

SEND FOR THIS NEW BOOK:
Chemical properties of Jalten
Mechanical properties of Jalten
Jalten equivalents
Jalten application data

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

STEEL



JALLOY
takes the beating

Jalloy plates shrug off truck-shaking impact and abrasion in the bed of this 34-ton, rear-dump Euclid during the mining of taconite ore.

Jalloy heat treated steels . . .

cut maintenance—give longer wear life

Jalloy—special purpose steels that are heat treated to provide longer wear on applications where impact and abrasive conditions are severe—last 4 to 20 times longer than conventional mild steels. Furthermore, they are easily welded.

Jalloy is available in three grades:

No. 1—for applications requiring excellent formability or where a low carbon alloy steel possessing good physical properties before or after heat treatment is specified. This is an ideal carbonizing grade.

No. 3—a general purpose steel capable of being heat-treated to excellent physical properties. Compared to ordinary mild steels it offers good resistance to abrasion or wear in the as-rolled state; but when heat treated to Brinell 340 and above, optimum abrasion and impact resistance is secured.

No. 7—possesses high hardness together with good ductility or wear resistance. Excellent for spring applications as well as flat work.

Jalloy high strength steels are available as plates, structurals, bar and small shape sections, hot rolled sheets, as well as strip and wire products.

• • •

Complete data concerning *Chemical Composition . . . Heat Treatment . . . Weldability . . . Physical Properties* . . . will be mailed to you promptly. Write today for your copy.

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

STEEL

For the

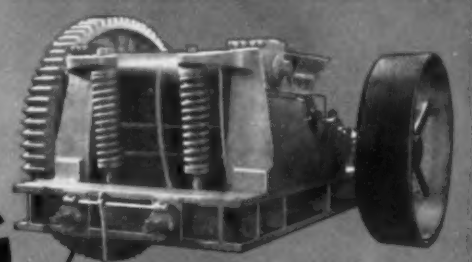
MOST DEPENDABLE

MOST ECONOMICAL

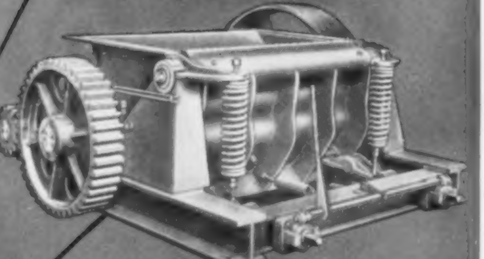
COAL CRUSHING EQUIPMENT

Specify

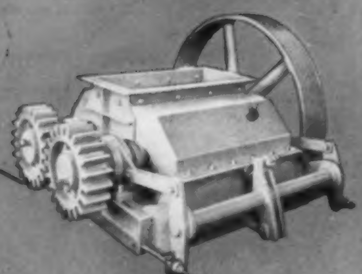
McLANAHAN



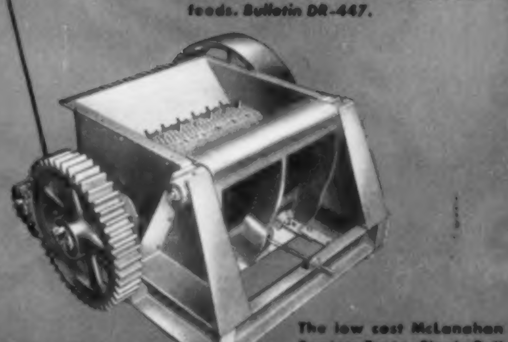
Single Roll Rockmaster Crusher for both primary and secondary crushing. Used in crushing mine refuse, sulphur balls, sand rock, slate, etc. *Bulletin RM-505.*



Single Roll Black Diamond Crusher with exclusive automatic steelstrut toggle and quick adjustment. *Bulletin BD-457.*



McLanahan Double Roll Crusher for various reductions of medium-size feeds. *Bulletin DR-447.*



The low cost McLanahan Bantam Buster Single Roll Crusher. *Bulletin BB-5112.*

Backed by 120 years of manufacturing experience, McLanahan builds crushing equipment for the ultimate in economy through long service and minimum maintenance costs. This equipment, which has been thoroughly service-proven on the most demanding of domestic and foreign installations, is available in a great variety of sizes for every coal crushing requirement. A pioneer in the development of many types of crushing equipment—including the first single roll crusher produced in 1894—McLanahan is equipped to produce complete units, from feeders, primary and reduction crushers through elevators, sizing screens, etc.

WRITE FOR BULLETINS: Separate bulletins are available on all the crushers shown, and on a wide variety of other equipment.

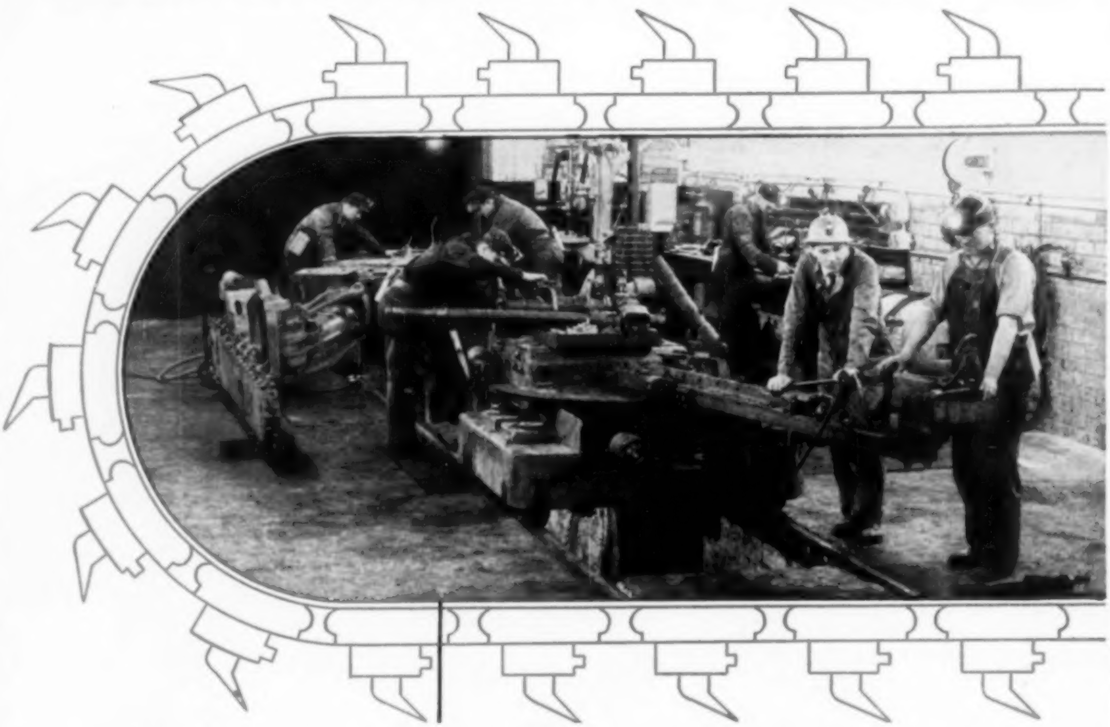
McLANAHAN & STONE CORPORATION

Pit, Mine and Quarry Equipment Headquarters Since 1835

Hollidaysburg, Pennsylvania

Dependable Products: Single and Double Roll—and Jaw Crushers, Crushing Plants, Reciprocating Plate and Apron Feeders, Roll Grizzlies, Conveyors, Elevators, Screens, Scrubbers, Steel Log Washers, Screw Washers, Blenders, Mixers, Sand Drags, Hoists, Jigs, Dry Pans, Dryers, Scrap Bundlers, Pulleys, Gears, Bearings, Sprockets, Sheaves, Rollers, Bin Gates, Elevator Buckets, Gratings, Car Wheels, Ferrous and Bronze Castings.

REDUCED MAINTENANCE COST WITH TRACY PARTS



REPAIR PARTS FOR GOODMAN, JEFFREY AND JOY CUTTING AND LOADING MACHINES

Ball Bearings	Cutter Arms	Rope Drums
Bushings	Cutter Chains	Shafts
Carbon Brushes	Controller Segments	Sheave Wheels
Clutches	Gears	Sprockets
Controller Fingers	Pinions	Worms
Controller Parts	Roller Chain	Worm Gears

REPAIR PARTS FOR JOY SHUTTLE CARS

Conveyor Parts	Wheel Drive Unit Part
Couplings	Wheel Parts
Shafts	Worms

Worm Gears

REPAIR PARTS FOR MINE LOCOMOTIVES

Axle Brasses	Controller Segments	Locomotive Gears
Ball Bearings	Journal Brasses	Locomotive Pinions
Controller Fingers	Journal Springs	Locomotive Tires

•

CUTTER CHAINS AND DRIVE SPROCKETS FOR GOODMAN, JEFFREY AND JOY CUTTING MACHINES
CUTTER BARS FOR GOODMAN, JEFFREY AND JOY MACHINES

•

ELECTRICAL EQUIPMENT

Armature Shafts	Carbon Brushes	Controller Segments
Cable Splicers	Controller Fingers	Controller Parts

MANUFACTURED BY **BERTRAND P. TRACY CO.** PITTSBURGH, PENNA.

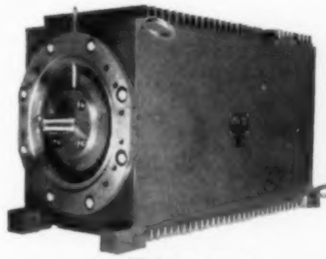
BRANCHES IN HARLAN, KENTUCKY • SMITHERS, WEST VIRGINIA
MILL AND MINE SUPPLY COMPANY, BIRMINGHAM, ALABAMA

When safety comes first . . .

YOU CAN BE SURE...IF IT'S Westinghouse

drive motors

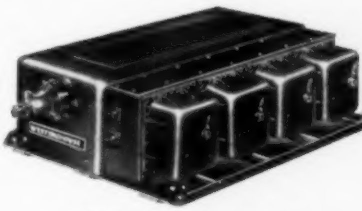
Explosion proof heavy duty type SK motor for service underground. Built for continuous mining machines or to drive coal conveyors or loaders. 50 hp, 230 or 500 volts d-c, 1150 rpm. Class B insulation (modified class H insulation available). 100°C rise over 20°C ambient. Continuous duty. Totally enclosed non-ventilated. Approved by U.S. Bureau of Mines for underground use. Frame 111.14SK.



type SK d-c mine motor

nitrogen-filled power center

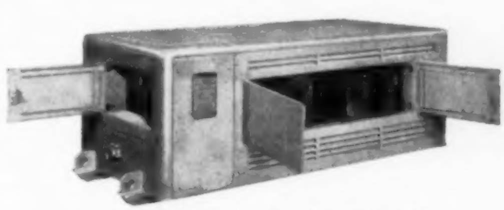
This portable mine power center is nitrogen filled and safe for underground service in explosive atmospheres. Approved by Pennsylvania Department of Mines. Only 25½ inches high, light in weight, and easily portable on its skid mounting. Contains no liquids. Core and coils of transformer are hermetically sealed. Explosion-proof type AB De-ion circuit breakers are included. Ratings: 75 to 500 kva; three phase; 60 cycles; high voltage, 2400 to 7200; low voltage, 240Y or 480Y with kva taps. Connections are quickly and easily made at new locations.



solid steel base with pulling eyes

ventilated power center

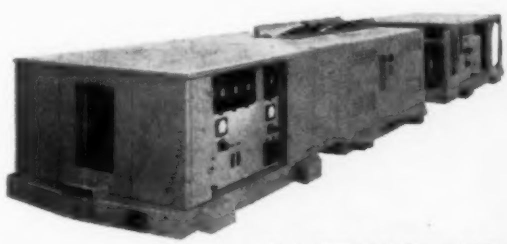
Ventilated dry-type mine power centers are compact units designed for dry underground mining service. Power center consists of—high voltage section, the transformer, and low voltage breakers. Transformer is of the non-explosive, fire-resistant, air-insulated dry-type construction. Class B insulation materials. Case is arranged for direct air cooling by means of louvers. Entire unit is mounted on skids and can be pulled along mine floor. A dolly with adjustable wheels is available for track use. Size 36" high, 45" wide. Ratings: 75 to 500 kva, three phase, 60 cycles, 2400 or 4160 volts on the primary, 240 or 480 volts on the secondary, and 240 volt single phase lighting circuit.



view of skid mounted unit from low-voltage end

ignitron rectifier substations

Westinghouse ignitron substations offer many advantages and increased efficiency in mining service over m-g sets for power conversion. These substations take high voltage a-c power from the incoming main line, transform it down to usable voltage, convert it to d-c, and send it off to the d-c driven machines—coal cutters, loaders, hoists, etc. Portable substations are built in three units and mounted on mine car wheels or on skids. Over-all height of 42 inches is available. They afford fully automatic operation, low maintenance costs, high efficiency at all loads, and will remain undamaged by extreme overloads.



A typical 3-truck Ignitron substation complete with dry type ASL Transformer, sealed Ignitron, automatic a-c and d-c switchgear

WESTINGHOUSE W

COMPLETE ELECTRICAL EQUIPMENT FOR THE MINING INDUSTRIES

driving motors

Westinghouse offers a complete line of motors in various speeds and horsepowers suitable for all mine drive service. In addition to open motors, explosion-tested and splash-proof types are available.

A-C Motors—Fractional or integral hp single, polyphase or universal, and squirrel cage induction, wound rotor or synchronous types can be supplied in standard voltages, frequencies and ratings from ½ to 200 hp to meet all requirements.

D-C Motors—Available in fractional or integral hp types with shunt, series or compound windings; also universal types can be supplied. Ratings from ½ to 200 hp for operation on all standard voltages.

enclosures

Types for a-c and d-c integral hp motors listed above include:

Open—For general purpose applications where operating conditions require no special protection.

Totally Enclosed—(non-ventilated or fan-cooled)—recommended where abrasive or metallic dust is present or where excessive quantities of dust of any kind are present. Explosion-Proof (totally enclosed or fan-cooled), recommended where the atmosphere may contain combustible or explosive dust or vapor in dangerous quantities. Motors built to comply with requirements of Underwriters Laboratories for Class I, Group D and for Class II, Groups E, F and G to comply with U. S. Bureau of Mines requirements for motors in hazardous locations underground.

Splash-Proof—for use where motors are frequently cleaned by hosing down. Construction prevents drops of liquid or solid particles from entering the machine.

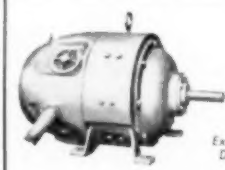
gearmotors and speed reducers

Westinghouse manufactures a complete line of parallel shaft type single or double reduction gearmotors and speed reducers for every requirement. Manufactured in accordance with the recommended practice of the American Gear Manufacturers' Association. For full details ask for Descriptive Bulletin 3600 (Gearmotors) or 6650 (Speed Reducers).

Gearmotors are self-contained drives, each consisting of a high speed Westinghouse motor and speed reducing unit. Available in all standard ratings of 1 to 75 hp, units can be furnished with practically any standard type Westinghouse a-c or d-c motor to meet individual requirements.

Speed reducers economically transmit power from high-speed motors or engines to exact speed requirements for driven machines. These units are the external geared type with shafts arranged in a horizontal plane.

integral hp motors



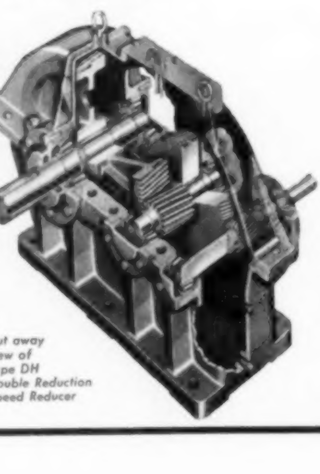
Explosion Tested Direct Current Type SK

Type ALDP

	direct-current		single-phase	
Motor Design	Shunt, Ser. or Comp. Wound	Series or Comp. Wound	Capacitor	
TYPE	SK	CKI[1]	ALDP	CAP
Starting Method	Across-the-Line or Reduced Voltage		Capacitor	
Starting Torque	High	High	Normal and High	
Hp Range—Motor	½ to 200	5 to 100	¾ to 10	
Speed Characteristics	Constant-Varying	Varying	Constant	
Approx. Full Load Rpm — 60 Cycle			3450 1755 1160	
Approx. Full Load Rpm — 50 Cycle	1750 1150 850 690 575	1350 1000 875 750 550	2880 1450 965	
Approx. Full Load Rpm — 25 Cycle			1450	
Standard Voltages	115 to 600	230	115/230	
Temperature Rise (Continuous Duty—Open)	40° C.	55° C. Intermittent	40° C	
Type of Bearings	Sleeve, Ball or Roller	Sleeve or Roller	Ball	
Method of Reversing	Change Leads—Use Suitable Control			

1—Crane & Hoist

speed reducers



Cut away view of Type DH Double Reduction Speed Reducer

Westinghouse Speed Reducers are of the external geared type with shafts arranged in the horizontal plane. Available in two types: Single Reduction (SH)-ratios-1.84 to 9.21, Double Reduction (DH)-ratios-11.3 to 70.0. Special features include:

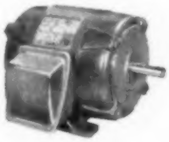
Simple Helical Gears—Teeth cut by the hobbing process for utmost accuracy. Exclusive Westinghouse BPT heat treatment given pinions and also to gears where necessary.

Simple Positive Lubrication—Efficient splash system assures thorough lubrication of gears and bearings. Labyrinth seal in end caps prevents oil leakage around shaft.

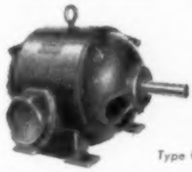
Anti-Friction Bearings—Tapered roller bearings are used throughout. They assure permanent shaft alignment—minimum friction loss and long, trouble-free service life.

motors · gearmotors speed reducers

polyphase a-c

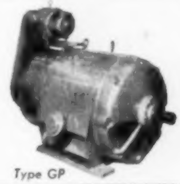


Life-Line A



Type CSP

Type CWP



Type GP

Squirrel-Cage Induction								Wound Rotor Induction		Synchronous
L-L A[2]	CSP[2]	L-L A[3]	CSP[3]	L-L A[4]	CSP[4]	L-L A[5]	CSP[5]	CWP	CIP[5]	GP
Across-the-Line or Reduced Voltage								Across-the-Line or Reduced Voltage		Across-the-Line or Reduced Voltage
Normal	Normal	High	High	High Torque High Slip	High Torque High Slip	High Torque High Slip	High Torque High Slip	High	High	Normal
½ to 40	1 to 200	3 to 30	3 to 150	½ to 30	½ to 125	½ to 30	1½ to 50	½ to 200	¾ to 200	20 to 200
Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant	Varying	Varying	Constant
3450, 1755, 1165, 860, 700	3450, 1755, 1165, 860, 700	1750, 1160, 870, 700	1750, 1160, 870, 700	Depends Upon % Slip 5% to 13% Slip Available	Depends Upon % Slip 5% to 13% Slip Available	1600, 1050, 800	1600 1050 800	1740, 1145, 860, 675	1740, 1140, 860, 680, 565	1800, 1200, 900, 720, 600,514
2880 1450 965	2880 1450 965	1450 965	1450 965			1340, 880, 670	1340 880 670	1450 965	1430, 950, 710, 575, 480	1500, 1000, 750, 720
1450 725 480	1450 725 480	725 480	725 480			1300, 880, 650, 670	1300, 880, 650, 670	1500 750 500	710 470	750 500
208 to 550	208 to 2300	208 to550	208 to 2300	220 to 550	220 to 550	208, 550	208 to 550	208 to 550 and 2300	208 to 550	208 to 2300
40° C.	40° C.	40° C.	40° C.	40° C.	40° C.	50° C. Intermittent	50° C. Intermittent	40° C.	50° C. Intermittent	40° C.
Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Ball	Sleeve or Ball
Change Leads—Use Suitable Control.										

[2]—NEMA design B. [3]—NEMA design C. [4]—Punch Press. [5]—Crane & Hoist.

gearmotors

Type A Single Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds (Motor rpm 1750)
2.24	780
2.73	640
3.37	520
4.17	420
5.00	350
6.25	280

Type C Double Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds (Motor rpm 1750)
7.61	230
9.21	190
11.3	155
14.0	125
17.5	100
20.8	84
25.7	68

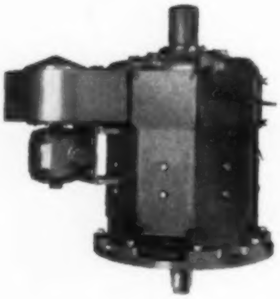
Type E Double Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds — Motor rpm 1750	1165	870
31.2	56	—	—
38.9	45	—	—
47.3	37	25	—
52.7	—	—	16.5
58.3	30	20	—

Type M Vertical Type, Double Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds — Motor rpm 1750	1150	870
7.61	230	—	—
9.21	190	—	—
11.3	155	—	—
14.0	125	—	—
17.5	100	—	—
20.8	84	—	—
25.7	68	—	—
31.2	56	37	—
38.9	45	30	—
35.0	—	—	25

Westinghouse equipment for shovels and draglines



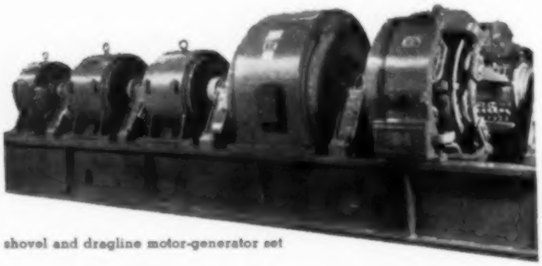
type MC vertical motor with forced draft ventilation

type MC motor

The type MC shovel motor is specially designed for hoist or drag service on smaller machines, and for crowd and swing on all types. Rated 7½ to 250 hp, it is rugged, compact, and gives fast starting, stopping, and reversing with safety. Small diameter armature has very low inertia. 230 and 550 volts d-c.

Horizontal motor—In this motor, used for the hoist, crowd, and drag, the motor frames are horizontally split. Top half swings up, exposing all operating parts, thus facilitating easy maintenance.

Vertical motor—Used for the swing operation, the frame is solid and can be removed by loosening the base bolts and lifting frame off.



shovel and dragline motor-generator set

motor-generator sets

Westinghouse M-G sets give you just the right amount of power for a highly efficient operation, with perfect co-ordination between generators and motors. Shovel and dragline motor generator sets are designed with the rating and operating characteristics matched to your specific drive.

Each armature is carried in two sealed ball bearings, making each unit complete by itself. Units of the set are flexibly coupled to allow for any shaft mis-alignment that may occur during operation. For small equipments Westinghouse has a dual-circuit generator for the swing and crowd motors.

Rototrol control unit

Rototrol®

Rototrol does a superb job of controlling motor speed and factors of torque, tension or acceleration regardless of varying load conditions.

Rototrol provides fast operating cycles with smooth acceleration and deceleration and limits mechanical stress in the shovel structure. Operator can work at top efficiency and doesn't have to worry about damaging equipment when applying full power.

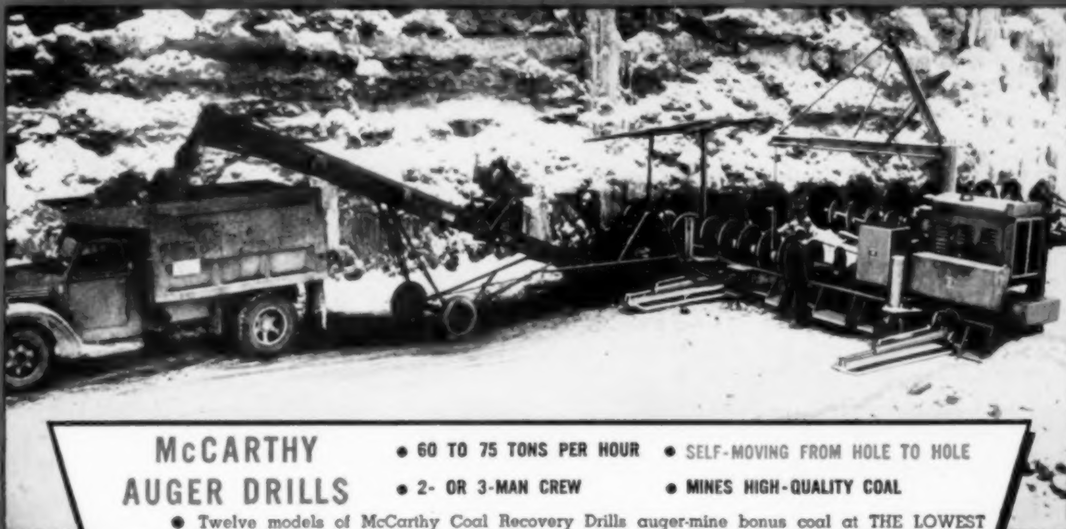
The drive is extremely fast. Rototrol takes the small amount of current within working ranges of the master controller and quickly amplifies it to a point where it "forces" the generators to instantly deliver the required power to the d-c motors. The system consists of a master controller, the Rototrol itself and a minimum of resistors and field circuit contactors. Because of its simplicity the Rototrol system is very easy to service.

skid-mounted portable switchouse, sideplates removed

portable switchhouses

Westinghouse portable switchhouses are used to carry the circuit protective equipment for individual shovel feeders. These units are skid mounted to facilitate easy movement as stripping progresses. This switchhouse handles three outgoing feeder cables. It contains an oil circuit breaker, disconnect switches, overload and ground protective equipment and plug-type receptacles.

Westinghouse Electric Corporation • P. O. Box 868, Pittsburgh 30, Pa.
See directory section of Mining Guidebook for list of Westinghouse offices.



McCARTHY AUGER DRILLS

- 60 TO 75 TONS PER HOUR
- SELF-MOVING FROM HOLE TO HOLE
- 2- OR 3-MAN CREW
- MINES HIGH-QUALITY COAL

● Twelve models of McCarthy Coal Recovery Drills auger-mine bonus coal at THE LOWEST operating cost per ton. They operate easily in narrow strip pits. Hydraulic controls simplify alignment, augering and changing position. Let us recommend the right cost-saving model for your property. Write for Bulletin M-101 and M-102.

SELF-PROPELLED

TRUCK-MOUNTED

Horizontal Earth and Rock Boring Auger Drills
150 ft. Drilling Depth

HEAVY-DUTY VERTICAL

Model 106-24—World's Fastest Heavy-Duty Vertical Auger Drill

● The self-propelled unit permits speedy, economical blast-hole drilling from hole to hole. It takes just a few seconds to disengage the power unit from the auger drive shaft, change position, and begin drilling again. The unit is easily attached to the McCarthy truck-mounted earth and rock boring drills now in use.

● Truck-mounted horizontal drills are highly versatile. The drilling unit mounts lengthwise or crosswise on the truck bed for spotting hole locations faster. Drilling height from the ground ranges from 4½ to 7 ft. Four separately operated levelling jacks permit close alignment. Write for Bulletin M-105.

● Bores vertical blast holes faster than any other auger drill. New gear reduction permits slower auger rotation for drilling larger holes deeper in harder rock formations. Augers 8″ and 9″ dia. drill holes to depths of 125 ft. for use of new type explosives. Controls can be placed at rear and auger racks can be furnished if desired. Write for Bulletin M-100.

FINGER-TIP CONTROL

Gives Desired Rotating Speed Of Auger

HYDRAULIC FEED

Provides Any Speed Up To 6 Feet Per Minute Horizontal Feed Of Drill

HEAVY   RUGGED   POWERFUL

MANUFACTURED BY

THE SALEM TOOL COMPANY

762 SOUTH ELLSWORTH AVE. • SALEM, OHIO, U. S. A.

SALEM

ROME 60® MINING CABLES

Neoprene sheathed . . . molded in lead for long service life

Rome 60 mining cables are Neoprene sheathed—molded in lead—for extreme durability and high resistance to oils, acids, abrasion and flame.

Conductors • All conductors are of finely stranded copper wires for maximum flexibility.

Insulation • A long-aging, heat- and moisture-resistant rubber compound permitting operation at 75° C., thereby providing overload protection. For high- voltage service an ozone-resistant insulation is used.

Reinforcements • On Rome 60 portable cables, a heavy reinforcing open braid locks the Neoprene sheath to the inner construction to prevent failure from twisting, pulling, flexing and sheath separation.

Sheath • Neoprene vulcanized in a continuous lead mold for durability and high resistance to abrasion, acids, oils and flame. All Rome 60 mine-trailing cables are surface-molded "P-105 BM" indicating full compliance with Federal and State of Penn. safety codes. These construction features, *plus* quality control, add extra service life to Rome 60 mining cables.

ROME 60 SINGLE-CONDUCTOR LOCOMOTIVE GATHERING CABLE—600 VOLTS

ROME 60 PORTABLE POWER CABLES—TWO, THREE AND FOUR CONDUCTORS
TYPE W (UNGROUNDED) UP TO 3000 VOLTS • TYPE G (GROUNDED) UP TO 5000 VOLTS

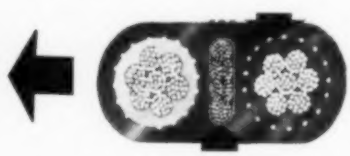
ROME 60 PARALLEL DUPLEX (FLAT TWIN) MINING MACHINE CABLE—600 VOLTS
TYPE W (UNGROUNDED) AND TYPE G (GROUNDED)

ROME THREE-CONDUCTOR HIGH-VOLTAGE FEEDER CABLES
WITH GROUND WIRES

ROME 60 (Flat Twin) SHUTTLE CAR CABLE EMPLOYS INTEGRAL SHEATH CONSTRUCTION

The rugged Neoprene sheath forms a resilient web between the insulated power conductors and the ground conductor to provide maximum impact resistance. The open braid on each conductor firmly interlocks conductors to sheath. The web and sheath are an integral unit which binds the entire cable securely together.

A greater number of finer strands in the power and ground conductors, plus a closely woven fibrous covering on the ground conductor (to minimize mechan-



ical working of the fine wire strands) increase the flexibility of the cable and protect it from constant flexing, twisting and tension.

THE ROME 60 LINE INCLUDES:

- Type SO portable cords
- Single-conductor locomotive cables
- Parallel duplex (flat twin) mining machine cables—Types W and G
- Multiple-conductor portable power cables Types W and G
- High-voltage feeder cables

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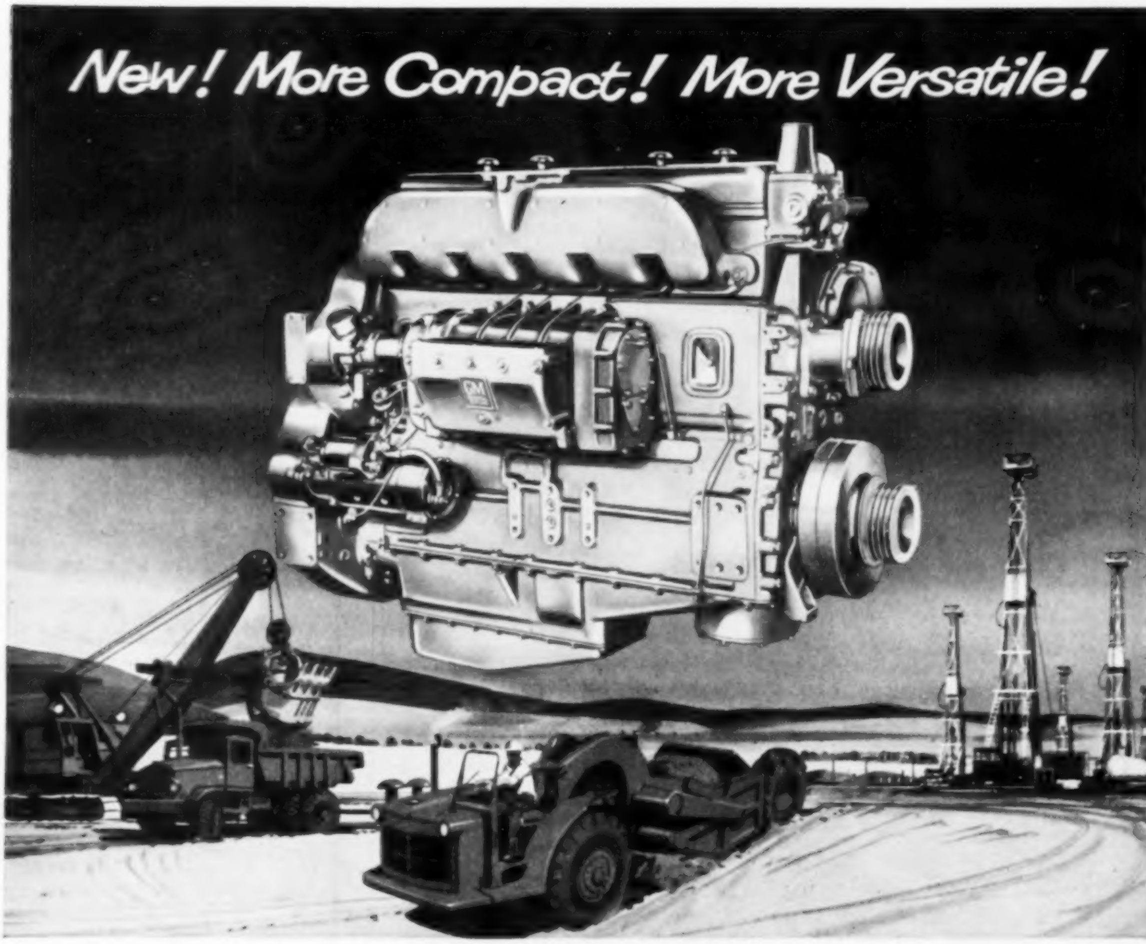


GM DETROIT DIESEL 300-HP SERIES 110 ENGINE

Now available to fit a broader range of power equipment

Now the best 300-horsepower Diesel is even better than ever—ready to step up production and cut costs in any job you name.

It's the time-proved General Motors Series 110 Diesel, newly equipped with a side-mounted blower similar to the one used on the famous 71 Series. It's a more compact engine. It's shorter. It's lower. It fits more applications than ever before.

You can have this new GM Detroit Diesel Series 110 engine installed in off-highway trucks and move bigger loads faster.

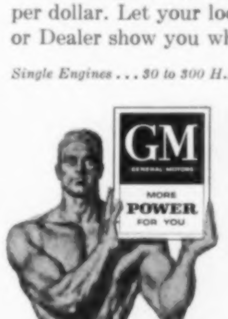
You can use it to increase the power of heavy crawler tractors and scrapers—get more work per day and per dollar.

And, in practically no time at all, you can have this new Series 110 Diesel installed in almost any 3-yard shovel—to move earth faster at less cost.

The new blower makes the Series 110 Diesel engine far more versatile—available with *either* right- or left-hand rotation, and wider range of accessory-drive outlets—*four* accessory drives on the rear of the engine and *four* fan-mounting positions on the front.

This new Detroit Diesel Series 110 engine takes on all comers in operating efficiency. It's a leader in work output per dollar. Let your local GM Detroit Diesel Distributor or Dealer show you what we mean.

Single Engines . . . 30 to 300 H.P. Multiple Units . . . Up to 893 H.P.



DETROIT DIESEL

Engine Division of General Motors
Detroit 28, Michigan
In Canada: General Motors Diesel Limited, London, Ontario

America's Largest Builder of Diesel Engines

Here's the Most Complete BUYERS' GUIDE You Can Find!

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1956 edition.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. You'll find more helpful product information in their advertisements.

COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers.

Large Coal Company in Southern West Virginia Operates 34 NOLAN PORTA-FEEDERS

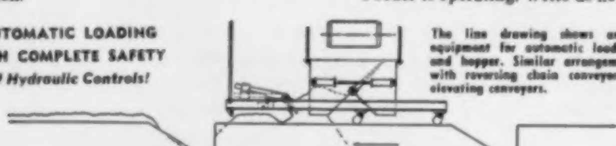
The trend is to the PORTA-FEEDER! More new orders . . . more repeat orders . . . in greater volume than all other similar types of feeders combined! 34 sold to one operator as a result of first PORTA-FEEDER installed!

TWO MODELS:
1. **Direct Mechanical Drive**
2. **Hydraulic Cylinder Type Hose Coupled in Remote Power Unit (Shown in Illustrations)**

These two Nolan models will help you meet every requirement and condition in spotting cars for loading . . . *and can save you many shift hours per day!* The Porta-Feeder mounts between the rails on top of the track ties, and is secured by rail clamps. No excavation or preliminary foundation work is necessary. There are no ropes or cables. Reciprocating pushing dogs deliver constant forward feeding motion.

The Nolan Porta-Feeder has been in successful use in many mines for over ten years. We will be glad to show you a mine in your vicinity where the Nolan Porta-Feeder is operating. Write us now.

AUTOMATIC LOADING WITH COMPLETE SAFETY
All Hydraulic Controls!



The line drawing shows arrangement of equipment for automatic loading from belt and hopper. Similar arrangements are used with reversing chain conveyors (yoyos) and elevating conveyors.

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THE NOLAN COMPANY
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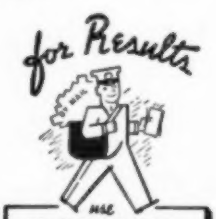
For complete, detailed information about our service, fill in the coupon or write for your copy of our free Business and Industrial Direct Mail catalogue.



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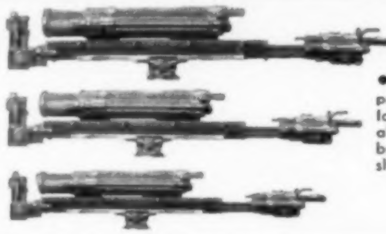
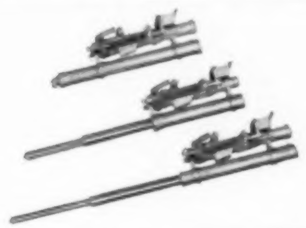


• Power-feed drifters. Dependable, powerful, and fast. Ideal for columns and jumbos alike. 3 sizes up to 4-inch bore. Also aluminum guide shells to 60-inch change.



• Stopers for every need — 75-lb., 90-lb., and 120-lb. sizes, and a complete line of offset stopers with 36-inch steel changes for deep holes, or with short feeds for confined spaces. Conventional or telescopic feeds.

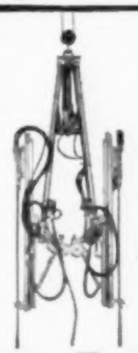
• A complete line of sinkers from 18 to 80 lbs. including the popular 45-lb. H10, and 55-lb. H111.

• A complete line of Jumbos, some with air-motor powered, self-leveling booms for quicker set-ups, greater safety, faster rounds.

• One-use detachable bits for sinkers, drifters and stopers. Special offset-gauge feature reduces binding and provides extra clearance for cuttings so that drilling speeds are faster. No rods to thread — just a simple taper connection.

• The Cleveland Air Leg can be used as a stoper, a drifter, a sinker. Supports sinker and also provides feeding pressure for faster, easier drilling. 3', 4', and 5' feed legs. Full range of drill rotations. Only one air hose required. Convenient feed-leg control valve gives any desired feeding pressure. Bayonet lock permits quick dismantling for easy transportation. Conventional or telescopic feeds.

• Air-feed sinkers — 2-way feed, 2 sizes. They take the back-breaking work out of drilling horizontal holes, lighten the load on your miners, and increase tonnages.



• The SDR 34 shaft sinker for faster shaft sinking. Available with two or four drills. All adjustments quickly made with air motor.

High Drilling Speed, Low Upkeep, Easy Handling Are Key Features of Le Roi-Cleveland Rock Drills

. . . and there's a size and type for every drilling operation in a mine

We've been designing and building rock drills for the mining industry since 1906. During this time we've pioneered many firsts — and during this time, you have taught us a great deal about your drilling problems.

Perhaps just as important as experience is the fact that building rock drill equipment is our only business. And building the best rock drills is our sole desire.

Today's Le Roi-Cleveland Drill is the product of this desire. As you look over the line-up shown here, you won't find a single machine that isn't a top performer in its rock-drill class.

Why? Because drilling speed, powerful rotation, and dependable durability are inherent in all Le Roi-Cleveland tools. Moreover, operators generally like them because they're easier to run.

This all adds up to more feet of hole drilled per shift, increased man-shift production, and lower costs.

We know that drilling costs are only a small part of your total cost picture. But we also know that you are interested in cutting any cost, no matter how small. We suggest, therefore, that you try Le Roi-Cleveland Drills — there's a size and type for every drilling operation. If you need additional information, just write us.

LE ROI Division of Westinghouse Air Brake Co., Milwaukee 1, Wisconsin, manufacturers of Cleveland Rock Drills.

RD-64

AMERICAN PULVERIZER COMPANY

Originators and manufacturer of American Rolling Ring Coal Crushers

**1275 Macklind Ave., St. Louis 10, Mo.
STerling 1-6100**

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COMPLETE LINE

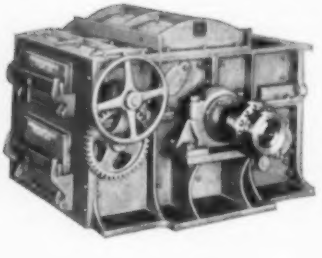
From large tonnage crushers wtih capacities up to 800TPH to Coal Sample Crushers, in a wide range of models and sizes, all custom designed to fit your specific operation.

EXPERIENCE

American has manufactured reduction equipment exclusively since 1908. American Rolling Ring Coal Crushers are in use all over the world and are famous for their dependability, low operating cost, and high output of uniform product.

ENGINEERING SERVICE

The Engineering Staff and experimental laboratory of American Pulverizer Co. provides a valuable service for analysis and recommendations of the proper type and size crusher for your operation.

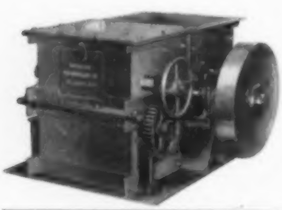


AMERICAN AC TYPE CRUSHERS

Capacities up to 800TPH. Extensively used for the reduction of ROM and lump coal to commercial screenings and stoker sizes. Operates at slow power saving speed, gives positive size control with a minimum of fines. Size of end product can be varied by external adjustments of grinding plate and drop cage.

Only American Crushers have the patented Rolling Shredder Rings which split coal instead of crushing it, thereby producing less fines.

Rings are made of manganese steel and are reversible to give double wear.

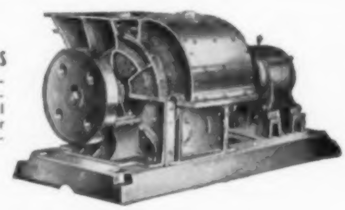


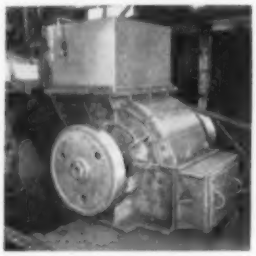
WC & WS SERIES

Made in 9 sizes with capacities up to 188 TPH. Very compact—makes ideal installation at mines or in yards underneath coal bin. External adjustments of Grinding Plate and Adjustable Drop Cage permits tailor made sizes to the truckload.

AMERICAN "S" TYPE CRUSHERS

Made in 8 sizes with capacities up to 500TPH for the reduction of ROM and lump coal to Screenings. Also used for crushing Middlings and Picking table refuse.



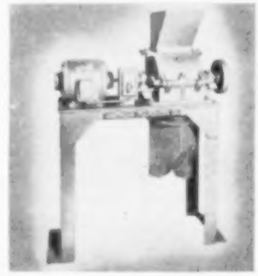


HEAVY DUTY "S" TYPE

Made in 4 sizes, with capacity up to 500 TPH. This Heavy Duty "S" Type Crusher reduces ROM Coal, gob, rock, slate, sulphur balls, etc. without oversize and eliminates the need for pickers. Pays for itself in short time in savings of labor and recovery of coal imbedded in impurities.

SAMPLE CRUSHERS

Made in two sizes with capacities up to 2000 lbs. per hour. Sampling hopper gives a 5%—10%—15%—20% Sample of The Sample—For larger capacities we recommend the American "WC" or "13" Series with capacities up to 12 TPH.



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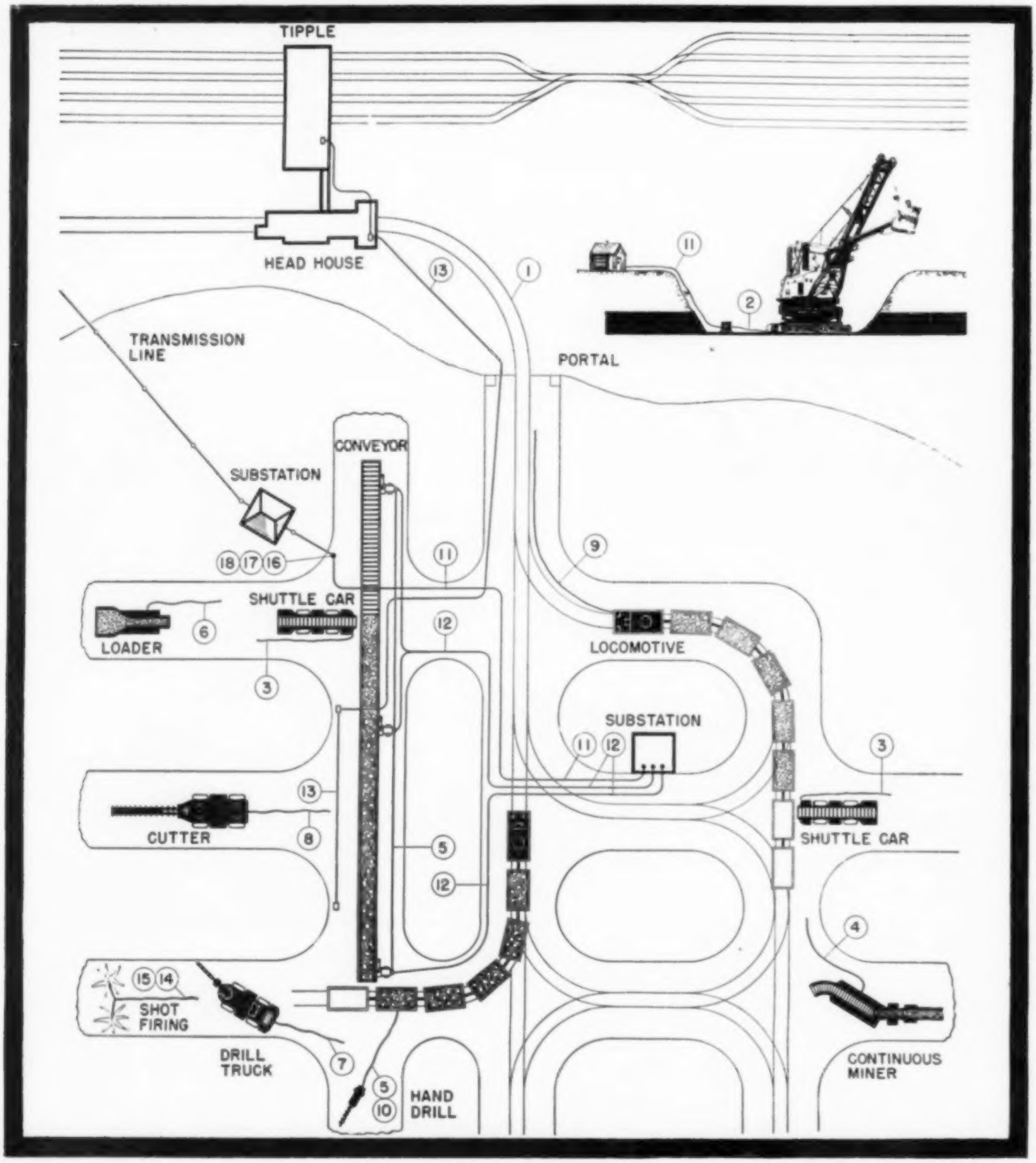


Choose your mine cable from this page

It takes a miner to understand mine problems.

And at Anaconda we're miners ourselves—as well as the world's largest manufacturer of mine wire and cable.

From tipple to mine face there are Anaconda wires and cables—designed, made and tested by mine cable experts—for *every* job in the mechanized mine. These wires and cables have proved records of safety and economy in mines all over the world.

Ask your Anaconda Distributor for these Anaconda products:

1) Trolley wire; 2) Shovel cable; 3) Shuttle-car cable; 4) Continuous mining-machine cable; 5) Remote-control and heavy-duty drill cord; 6) Loader cable; 7) Drill-truck cable; 8) Mining-(cutting) machine cable; 9) Gathering-locomotive cable; 10) Hand-drill cord; 11) Mine-power cable; 12) Low-voltage power and feeder cable; 13) Telephone cable; 14) Shot-firing cord; 15) Blasting-cap wire; 16) Borehole and mineshaft cable; 17) Anaconda suspension unit for borehole cable; 18) Armored cable suspension unit.

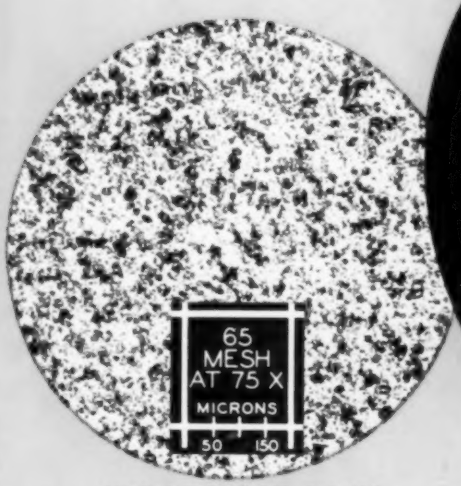
For more information, call or write Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 56543

ANACONDA®

Now-a choice of

3 AEROFLOC® Reagents

to flocculate wash-water fines
to accelerate settling and
assure a clear plant effluent



UNFLOCCULATED SLIMES

AFTER ADDING AEROFLOC REAGENTS

Study the photomicrographs above. Note how the addition of only 0.01 to 0.1 lb. per ton (0.1 to 5 ppm in dilute suspensions) of AEROFLOC Reagent flocculated the finely divided solids. Visualize how such powerful flocculation can improve settling of your wash-water fines and thereby minimize your stream-pollution problems.

Plant tests of AEROFLOC Reagents have shown amazingly good results. In one typical instance washery effluents containing 0.15% solids, too high for safe discharge into a stream, were treated with 0.013 lb. AEROFLOC 548 per 1,000 gallons of effluent. The solids content of the overflow was reduced to 0.005%, clear enough for discharge into the stream.

Three AEROFLOC Reagents are available—#548, #552 and #3000 each with special characteristics. We suggest that you test all three because it is not possible to predict accurately which will perform best in any given application. Samples and technical data will be sent on request.

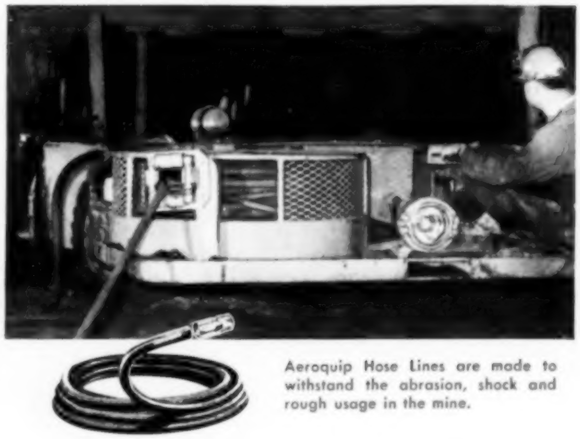
AMERICAN CYANAMID COMPANY

MINERAL DRESSING DEPARTMENT

30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

CYANAMID

Aeroquip Bulk Hose and Reusable Fittings Speed Field Replacement



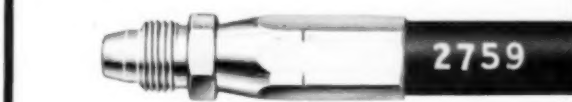
Aeroquip Hose Lines are made to withstand the abrasion, shock and rough usage in the mine.

Make all your replacement lines quickly, easily, with Aeroquip Bulk Hose and Reusable Fittings. Just cut the length of hose needed and attach the fittings using ordinary shop tools. A few coils of Aeroquip Bulk Hose and some reusable fittings are all you need to replace hose lines on all kinds of mining equipment. Call the Aeroquip Distributor listed in your local Yellow Page Directory.

SELECT THE HOSE THAT FITS YOUR NEEDS

MEDIUM PRESSURE COTTON COVERED HOSE

Single wire braid 1503 Hose with oil and mildew resistant cotton braid cover is recommended for hydraulic lines up to 3000 psi. Ideal for fuel, oil, air and water lines, too. In sizes from 1/4" to 2½".



COAL SHOOTING PNEUMATIC HOSE

Multiple wire braid 1509A Hose with synthetic armorite cover (or 2759 Hose with perforated rubber cover) is especially designed for coal shooting operations. Standard 3/16" size with male flare fittings.

HIGH PRESSURE HYDRAULIC HOSE

Double wire braid 1509 Hose with tough rubber cover is recommended for all high pressure hydraulic lines up to 5000 psi., depending on size. In sizes from 1/4" to 2".

MEDIUM PRESSURE RUBBER COVERED HOSE

Single wire braid 2651 Hose with abrasion, oil and mildew resistant rubber cover. For hydraulic, oil, fuel, air and water lines up to 3000 psi. No skiving is necessary. Fittings fit right over hose cover. 1/4" to 2½".

SELF-SEALING COUPLINGS

Aeroquip 5100 Self-Sealing Couplings connect and disconnect hydraulic, fuel, oil and air lines quickly, with no loss of fluid or inclusion of air or foreign matter into the system. Valve faces are easy to clean. Sizes 1/4" to 1¼".

EQUIPMENT MANUFACTURERS

Write for Catalog No. 200 for full information on Aeroquip products plus helpful engineering data.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

JOY PRODUCTS FOR COAL MINES

The world's most complete line of modern mining equipment

EQUIPMENT FOR ABOVE GROUND

EXPLORATORY (Deep and Strip Mines)
Diamond Core Drills . . . Core Drill Bits . . . Core Bit Resetting Service . . . Core Drilling by Contract

SURFACE PLANT (Shaft or Slope Mines)
Stationary Air Compressors . . . Utility Hoists . . . Cutter-Bit Heaters and Sharpeners . . . Bit Tempering Plants . . . Oxygen Plants . . . "String-a-lite" Portable Lighting

STRIP MINES (Anthracite and Bituminous)
Portable Air Compressors . . . Rock Drills and Bits . . . Blast-Hole Drills and Bits . . . Wagon Drills . . . Horizontal and Vertical Strip Borers . . . Coal Borers . . . Finger Bits . . . Cable Vulcanizers . . . Electrical Cable Connectors . . . "String-a-lite" Portable Lighting . . . Oxygen Plants

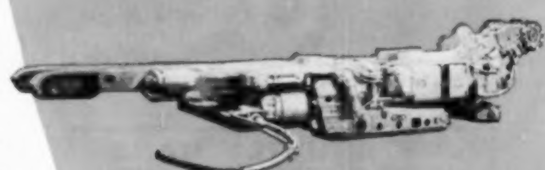
EQUIPMENT FOR BELOW GROUND

DEVELOPMENT (Anthracite and Bituminous)
Mine Car Compressors . . . Rock Drills and Bits . . . Drill Jumbos . . . Hitch Drills . . . Diamond Core Drills . . . Core Drill Bits . . . Rock Loaders . . . Scraper Loaders

PRODUCTION
Continuous Miners . . . Coal Borers . . . Shuttle Cars . . . Coal Loaders . . . Mining Machines and Utility Trucks . . . Auger Bits . . . Elevating Conveyors . . . Post Pullers . . . Timber Setters . . . Caterpullers . . . Safety Coal Drills . . . Mobile Rotary Coal Drills . . . Roof Bolting Drills—Hydraulic, Pneumatic . . . Coal Cutters—Universal, Shortwall, Longwall . . . Cutter Bits . . . Bugdusters . . . Carpullers . . . Room Hoists . . . Conveyors—Belt, Shaker, Chain . . . Belt Feeders . . . Electrical Cable Connectors . . . Cable Vulcanizers . . . Power Distribution Systems . . . "String-a-lite" Portable Lighting Systems . . . Track Switch Throwers . . . Bit Heaters

JOY CONTINUOUS MINERS

3JCM-4—MEDIUM SEAMS



Only 34″ high for seams 40″ or higher; rated capacity, 2-3 tons a minute. Sumps 18″ deep, 39″ wide; cuts from 5½″ below to 66″ above floor (93″ with special equipment).

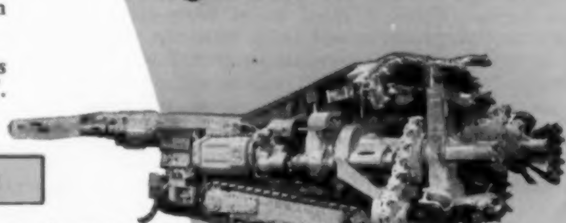
Total HP, 167; L., 26′8″; W., 90″; Room Widths: 17′3″ max., 11′10″ min. Conversion kits available to bring older 3-JCM models up to date. Bulletin J-401.

1-CM—MEDIUM HIGH SEAMS

Heavy-duty, 4-tons-a-minute capacity unit, 45″ high, for seams 52″ and higher. Sumps 18″ deep, 42″ wide; cuts from 5½″ below to 90″ above floor (120″ with special equipment). Total HP, 245; L., 27′6″; W., 92″; Room Widths: 19′ max., 12′ min. Bulletin J-403.

Also available with 4,200-lb.-thrust hydraulic roof drills as 1CM-2B: Total HP, 271; L., 28′8½″; W., 117″. Bulletin J-404.

TWIN BORER



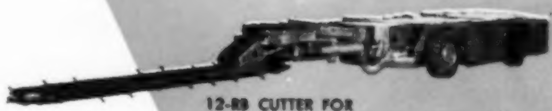
Full-face continuous miner, 8-tons-a-minute capacity, cuts about 6 to 8 ft. high, 12 ft. wide. Self-propelled, easily maneuvered; raises, lowers, tilts hydraulically to follow coal seam. All cutting surfaces retract hydraulically for clearance. Bulletin C-52.

EXTENSIBLE BELT CONVEYOR

Simple, continuous haulage system for distances to 1000 ft. extends or retracts 50 ft. while carrying material; stores belting in drive section. New 100-ft. belting changed in 5.3 minutes. Belting supported by lightweight, portable Limberoller idler sections. Drive and tail crawler mounted. Bulletin J-303.

JOY MANUFACTURING COMPANY

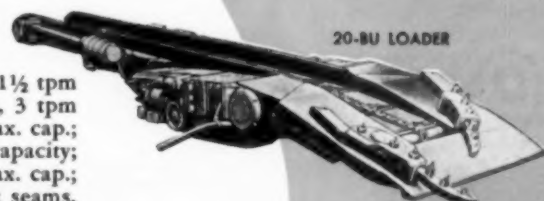
JOY COAL CUTTERS



12-RB CUTTER FOR VERY LOW COAL.

Complete line: shortwalls, longwalls; track or rubber-tire mounted Universals. Floor Types: 5-B1 shortwall, 10 HP; 11-B with automatic bugduster for conveyor mining, 35 or 50 HP; 7-B shortwall with bugduster, 50 HP; CLE-5 longwall, 50 HP, 12" high, 28" cutting width, air or electric drive. Mounted Units: 10-RU trackless universal for thick seams; 11-RU universal, 31" high, for medium seams; 12-RB rubber-tired top or bottom cutter for thin seams; 10-AU track-mounted universal.

JOY LOADERS



20-BU LOADER

Eight models: 12-BU for conveyor mining, 29" high, 1½ tpm max. cap.; 8-BU lightweight loader for bad conditions, 3 tpm max. cap.; 20-BU for very low coal, 24" high, 8 tpm max. cap.; 20BU-3, special model for conveyor work, 5 tpm capacity; 14-BU for medium seams, 30½" or 36" high, 8 tpm max. cap.; "Super" 14-BU with 10 tpm max. cap.; 11-BU for thick seams, 10 tpm max. cap.; 30-BU for split seam work, 43" high, 10 tpm max. cap.; extra-rugged 18-HR-2 for rock or ore loading, 65½ or 87" high, 12 tpm max. cap. All have the original Joy gathering arm principle, brought to perfection through years of field testing and development.

JOY SHUTTLE CARS

8-SC SHUTTLE CAR

Another Joy original, backed by years of field proof and constant design improvements. Available in eleven models with capacities from 2 to 14 tons and heights from 26" to 66"; cable reel or battery power. All have disc brakes; power steering, Magnetax Control, specially designed bodies that permit easy access with loader boom and quick interlocking when one unit used as surge car. Seven models have 4-wheel drive, 4-wheel steer, 4-wheel brakes. Four have interchangeable wheel units. When requesting additional data, please give seam height.

JOY COAL DRILLS

CD-42 DRILL

Hydraulic or electric; track or rubber-tire mounting; mountable units. Trackless units include: single-boom CD-22 for thin seams, 30" high; single-boom CD-25 for medium seams; twin-boom CD-26 for wide rooms, 30" high; twin-boom CD-42 with continuous auger feed, automatic spotting and positive holding features, 43" high. Single-boom CD-24 is track mounted; 30" high above track. Single-boom CD-23 is a movable-boom unit for mounting on 10-RU or 11-RU cutter chassis.

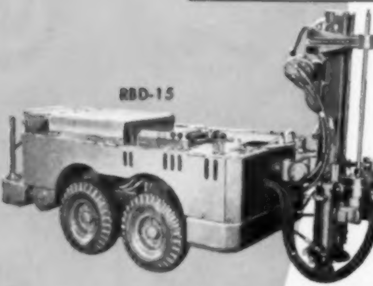
JOY CARPULLERS

CHL

Carpullers feature fully enclosed working parts, anti-backlash brakes, automatic motor-shaft brake and Alemite pressure fittings. The CHL, 5 to 10 H.P., has a rope pull equal to the draw-bar pull of a 15-ton locomotive. The CHD, 10 or 15 H.P., has a rope pull equal to the draw-bar pull of a 30-ton locomotive. Arranged for remote control. Bulletin 76 S.
Ropepullers, and single, two and three drum hoists also available. Bulletin 76-X.

JOY MANUFACTURING COMPANY

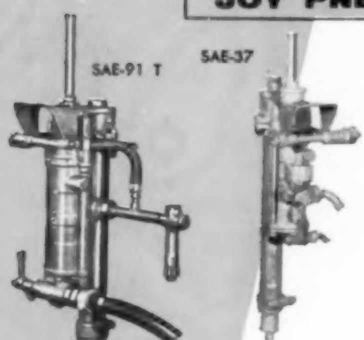
JOY HYDRAULIC ROOF BOLTING DRILLS



RBD-15

Compact, self-contained, self-propelled units with high maneuverability, great drilling power and unequalled flexibility. Instant adjustment of infinitely variable combinations of thrust, feed speed, rotation speed and torque; thrusts to 5500 pounds at 1050 psi. Single unit RBD-15 turns in its own 114-inch length; is 33″ or 37″ high for seams from 42″ to 96″. Twin-boom RBD-11 uses same drill unit on each 9½-ft. boom; offers 23-ft. drilling range; is 43″ high. Bulletin C-50.

JOY PNEUMATIC ROOF-BOLTING STOPERS



SAE-91 T SAE-37

Dual valve units with centralized feed controls, "push-button" release, corrosion-resistant cadmium-plated parts, constant feed and feed pressure throughout the entire extension of the telescopic feed leg. Lightweight telescopic SAL-37 has 30″ steel change; short-length SAE-91 has 14″ steel change, also available with 18″, 24″, 30″ and 36″ steel changes; SAE-91T has telescopic feed for steel changes to 30″; SA-91T, collapsed length 40½″, steel changes to 48″; S-91T provides 36″ steel change with overall length of 52″.

JOY MINE-AIR COMPRESSORS

Mine-Air Compressors are two-stage units. Two-stage compression is approximately 15% more efficient than single-stage compression. Complete air-cooling eliminates cooling water piping, and scale in the cylinder jackets. Force-feed lubrication assures proper lubrication of working parts and minimizes cylinder wear and friction losses.

WK-83

Joy builds a complete line of highly efficient, ruggedly constructed, portable air-compressors for underground service. Class WK-82 compressors are drawbar types. Class WK-83 compressors are self-propelled. Each class has four sizes, delivering 130, 175, 240 or 275 C.F.M., track-mounted or mounted on rubber tires.

JOY STATIONARY AIR COMPRESSORS

WN-112

For the maintenance shop, cleaning plant, or for permanent installations to supply compressed air by pipeline to an entire mine for roof-bolting, Joy has a complete line of modern stationary compressors with displacements from 2 C.F.M. to 3896 C.F.M., at 100 psi. They are available both in air-cooled models for intermittent duty, and in double-acting, water-cooled models for heavy-duty, continuous operation.

JOY PORTABLE COMPRESSORS

The Joy "Series 80" line of portable compressors includes five sizes ranging from 75 to 600 CFM. Efficient, dependable air plants, these Joy portables were designed with economy in mind —engines are matched to compressors, valves constructed with low lift and large port areas, cross-flow inter-cooler for efficient air cooling, "Econo-Miser" load control for fuel savings. Details in Bulletin A-55.

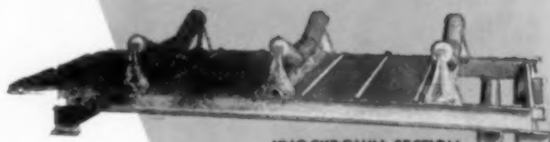
JOY MANUFACTURING COMPANY

JOY BELT CONVEYORS

Joy Belt Conveyors are available in either single pulley or tandem pulley drives for all belt widths, and in a wide range of power, to meet almost every mining application, whether underground or on the surface. Standard models, range from 15 to 300 H.P.

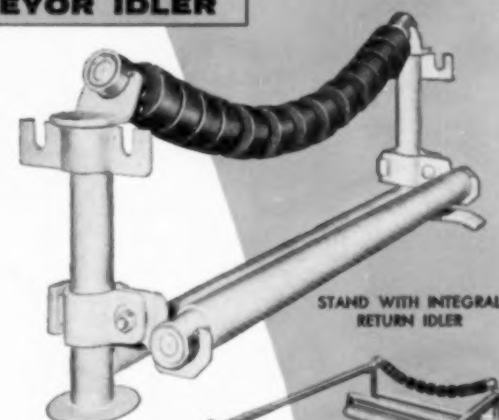
Rugged knockdown type intermediate sections are available for all conveyor belt widths. Compact for low-cost transportation, units are easily and quickly assembled into a finished installation by the user at the site. Joy also offers deep laced trussed frame intermediate sections for above ground applications.

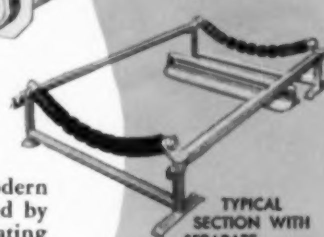
Idlers in diameters of 4, 5, and 6″, ball bearing or roller bearing types.



JOY "LIMBEROLLER" CONVEYOR IDLER

Flexible, 2-bearing suspension idler shapes itself to the load. Resilient, pressure-molded neoprene discs, molded to a neoprene-sheathed, flexible steel cable, supports the belt without slipping; cushions the load; keeps belt and idler wear to a minimum. Discs resist abrasion, corrosion, flame and oil. LIMBEROLLERS weigh ⅔ less than steel idlers; are quickly mounted on special stands that connect like a bed frame into sections for fast assembly; permit lower overall height than any other conveyor. Units, complete with matching drives and tails, can be set up in extremely low seams and still meet regulations. Simple no-bolt construction means easy handling in tight places. Available for belt widths of 24″, 30″ and 36″. Bulletin LD-105.





OTHER JOY CONVEYORS

Joy also offers a complete line of chain-and-flight conveyors, featuring modern design drive sections with built-in helical gear speed reducers, and powered by V-belt drive from motor. Also available is an equally complete line of Elevating Conveyors in a horsepower range from 7½ to 25 HP, designed to fit customer's needs as to capacity, shape and mounting.

JOY AXIVANE® MINE FANS and BLOWERS

Joy Axivane mine fans are designed to provide efficient and dependable ventilation for underground mining. The Joy mine fan has 5 exclusive features which mean savings in operating costs: Low operating speed, wide operating range, simultaneous blade adjustment, built-in steel base, ready bearing accessibility.
Available in two types: High Pressure and Intermediate Pressure.

Joy portable blowers are all purpose units that operate with unmatched efficiency providing low cost ventilation wherever air movement is needed. These blowers are available with electric direct drives, electric V-belt drives, or gasoline engine V-belt drive. Permissible models are available for gaseous mines.

JOY MANUFACTURING COMPANY

JOY BLAST HOLE DRILLS

There's a Joy drill for any strip mine drilling operation. For vertical blast holes, drills range from the Super Heavyweight Champion down to wagon drills. For horizontal blast holes, the Joy Horizontal Stripborer is the answer. For utility drilling and breaking there is a complete Joy line of hand held drills and paving breakers.

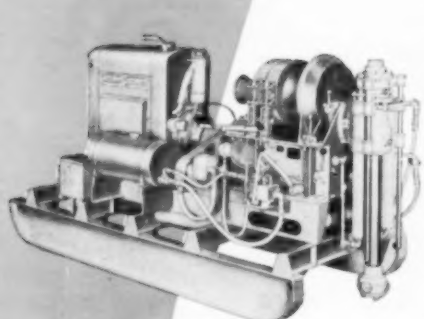
The Champion blast hole drills are rotary air-blast drills, crawler mounted for extreme mobility. The largest model, the 60-BH Super Heavyweight, drills holes up to 12" diameter. The model 58-BH Heavyweight drills holes to 7⅝" dia.; model 56-BH drills to 6¼" dia.; in any formation where rotary cone-type bits are applicable.

Another rotary air-blast drill is the truck-mounted model 225 Blastair. The Blastair is designed for drilling holes to 6¼" diameter.

For drilling in the hardest formations, Joy pneumatic drills of the Challenger class offer a range from 3½" to 4½" holes to any depths required for strip mining. Challenger Drills are self-propelled, either on rubber tires or crawlers, and mount either the Joy TM-500 or TM-450 pneumatic drill.

Where smaller, more shallow holes are sufficient for blasting, Joy Wagon Drills are tops for peak yardage. Rugged, mobile mountings provide fast setup and drilling. Long feeds reduce number of steel changes required. Mediumweight and Lightweight models mount hard-hitting Joy drifter drills.

Hand held rock drills for utility drilling include five models ranging from the lightweight L-27 to the 55-lb. class LB-57. Breakers in 30, 60, 80, and 90-lb. classes provide a complete line of efficient, easy-to-operate "busting" tools.



DIAMOND CORE DRILLS

Available in a variety of models and sizes, Joy Diamond Core Drills are the ideal drills for proving up mineral deposits. Light, medium, and heavy-duty machines, skid-mounted for portability, remove accurate core to depths of 2250 ft. All models are available with gasoline, diesel, or electric drive and with either hydraulic or screw-feed swivelheads. Write.

Core Drilling by Contract. Sub-surface test borings for mineral prospecting and locating dams, bridges; grout hole drilling. Skilled crews and complete stock of core drills and equipment.

Truco Diamond Bits. Quality diamonds set for proper clearance in patented, abrasive-resistant, tightly gripping matrix. Available in all standard sizes; special types and sizes for unusual applications; serviced by field engineers.

Resetting Service—prompt, world-wide, efficient. Salvaged and new diamonds combined for best service.

SAFETY CIRCUIT SYSTEMS

You can't buy better protection . . . or less expensive protection . . . against damage caused by electrical shorts, overloads and ground faults than JOY S. C. C. units provide. Equipped with "split second action breakers" that can be quickly reset with exterior handles . . . they're available in a wide range of A. C. and D. C. ratings for Strip or Underground mining applications.

FOR STRIP MINING

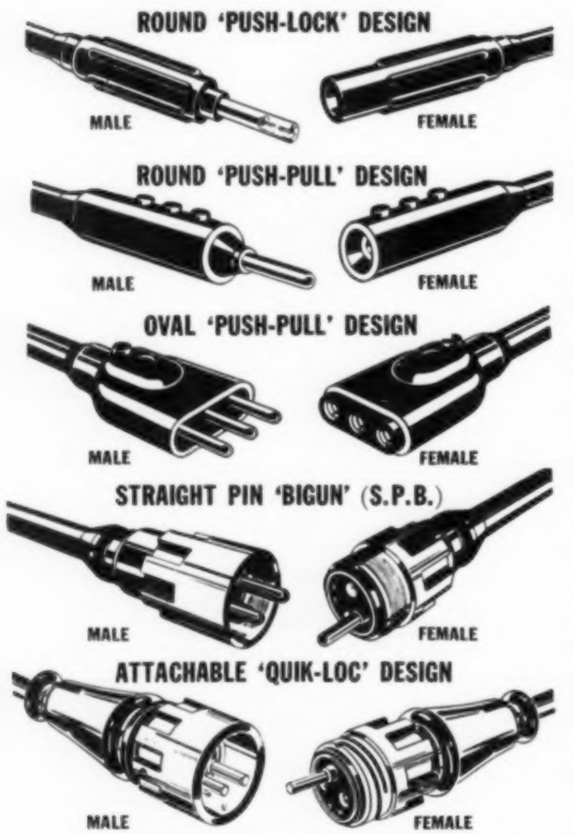
Design illustrated has a built-in derived neutral grounding transformer that provides a connection for fourth wire or safety ground on delta connected systems. Breaker has adjustable magnetic trip for main power circuit. Single conductor input leads enter housing at rear through insulated grommet type bushings. Each phase and ground wire is wired in groups to separate, identified outlets.

FOR UNDERGROUND MINING APPLICATIONS

Supplied with Dust-tight or Permissible style housings for both standard and thin seam operations. *Permissible designs fully approved by U. S. Bureau of Mines for use in gaseous locations.* Available with one through four individually protected power outlets. Convenient exterior handles, that reset breakers, also may be manually used to turn current off and on. Intrinsically safe control circuit provided in all permissible styles (makes Connectors drop load in opening process) also available on Dust-resistant styles. Safety Ground trip optional, all models.

JOY MANUFACTURING COMPANY

Electrical Connectors and Associated Equipment



Whatever your plans for the future, "electrically speaking" you should become acquainted with JOY connectors . . . for in all those qualities that add up to long, trouble-free and efficient service, JOY plugs and receptacles excel. Each of the five basic types illustrated has been carefully designed for power connecting needs in mining operations. All are factory-molded of flame-resistant Neoprene compound. All are highly resistant to the aging effect of oils, acids, alkalies and rough treatment. They're shatter-proof, moisture-tight and distortion resistant. "Molded-to-cable" styles (see description below) are supplied on 12" to 36" cable leads unless otherwise specified. Length furnished depending on number and size of conductors.

PUSH-LOCK DESIGN . . . Available in single conductor only. Cannot become accidentally disengaged. Choice of "Molded-to-cable" or "Attachable" designs for 32 volt welding through 5000 volt applications.

ROUND PUSH-PULL . . . Available with one through twelve conductors in a wide variety of functional designs. Voltage range 600 or less. Currently supplied only in "Molded-to-cable" style.

OVAL PUSH-PULL . . . Available with two through four conductors for voltages of 600 or less—very popular. Lay flat, cannot roll. Currently supplied only in "Molded-to-cable" style.

STRAIGHT PIN BIGUN (S.P.B.) . . . Have corrosion proof, threaded metal couplings. Available with one through four conductors with or without additional pilot control contacts. Voltage range 600 or less. Currently supplied in "Molded-to-cable" style only.

ATTACHABLE QUIK-LOC . . . Corrosion proof metal couplings fully engage and disengage in ¾ turn. Available with one through four conductors with or without additional pilot control contacts. Currently supplied in "Attachable" design (as illustrated) only.

MATING RECEPTACLES . . . Available for all Joy electrical plug designs on this page. See Bulletin B39a for detailed information on Joy's line of electrical connectors for mining needs.

Ask us for descriptive literature on JOY Connectors and S. C. C. Units

. . . ABOUT THESE OTHER JOY PRODUCTS

CONTINUOUS MINERS, MOBILE LOADERS, SHUTTLE CARS, COAL CUTTERS, CUTTING MACHINE TRUCKS, COAL DRILLS, CONVEYORS, POSTPULLERS, TIMBER SETTERS, SHUTTLE CAR ELEVATORS, BELT FEEDERS, FANS, SULMET BITS, PORTABLE BLOWERS, COMPRESSORS, ROCK DRILLS, HOISTS, CORE DRILLS, CORE DRILLING BY CONTRACT, SAFETY CIRCUIT CENTERS, MINES EQUIPMENT CONNECTORS.

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Pa., Forty Fort............................155 Welles St.
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Ontario, Kirkland Lake................24 Duncan Ave.
Ontario, Sudbury.............................61 Eyre St.
Ontario, Toronto.......................208 King St., W.
Quebec, Montreal..................................
.............364 Montee DeLiesse, Ville St. Laurente

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JOY MANUFACTURING COMPANY

GENERAL OFFICES—HENRY W. OLIVER BLDG., PITTSBURGH 22, PA.

The company reserves the right to alter or improve the design or construction of its machinery as described herein and to furnish it, when so altered, without reference to the illustrations or descriptions in this bulletin.

Duff-Norton Jacks

are safer, sturdier, faster, more economical—meet every modern mining need!

SINGLE ACTION RATCHET LOWERING JACKS WITH FOOT LIFT

514-MT
516-MT
521-MT

1017
1020
1022

1522
1528

2028

5 TONS Furnished with double round sockets and steel operating lever 1" x 30". *When jack is not under load,* head can be dropped or tripped instantly.

10 TONS Furnished with either of the following sockets and operating levers: double round or small single round and steel lever 1¼" x 60"; large round and wooden lever 2⅞" x 48"; or square socket to fit your own lining bar.

15 TONS Double round socket and steel lever bar 1¼" x 60" long are standard equipment. Also furnished with large round socket and wood operating lever 2⅞" x 48" long; or square socket to fit your lining bars.

20 TONS Double round sockets and steel lever 1¼" x 60". Also furnished with small single round socket; large round socket with wooden lever 3⅛" x 66"; or square socket to fit your lining bar.

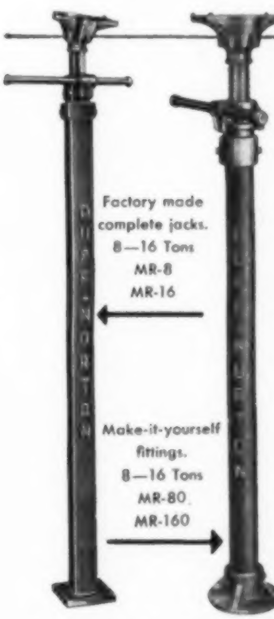
Jacks can be furnished with either curved or flat tops.

Every Duff-Norton ratchet jack is guaranteed at full capacity for loads applied to either head or foot lift.

Jack No.	514-MT	516-MT	521-MT	1017	1020	1022	1522	1528	2028
Cap. Tons	5	5	5	10	10	10	15	15	20
Ht. Ins.	14	16	21	17¼	20	22	22	28	28
Raise Ins.	7½	9½	14½	9	11½	12	11½	17½	18
Ft. Lift Ht. Ins.	1½	1½	1½	2¼	2¼	2¼	2½	2½	2½
Weight Lbs.	31	34	41	55	59	65	82	96	103

*Duff-Norton Patented spring mechanism, one complete unit—easily replaced.

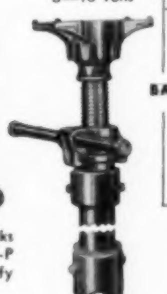
MINE ROOF JACKS AND FITTING



Factory made complete jacks.
8—16 Tons
MR-8
MR-16

Make-it-yourself fittings.
8—16 Tons
MR-80
MR-160

Angle Jack
8—16 Tons

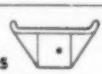


Pin timbering jacks
8—16 Tons

For pin timbering or angle jacks with square tubing, specify MR-8-P or MR-16-P. For round tubing, specify MR-80-P or MR-160-P.

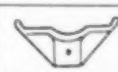
JACK FITTINGS The following five heads, three handles, and three bases are available in any combination:

HEADS



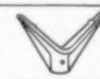
TYPE "H"—used with 4" H-Beams or rails.

TYPE "B"—ball and socket for flat timbers, beams or direct contact.



TYPE "T"—6½", 8¼", and 11¼" sizes for H-beams, round or square timbers.

TYPE "L"—for angle support of ends of timbers, beams or rails.



TYPE "V"—for various diameter round timbers.

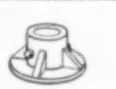
HANDLES

SLIDE HANDLE—for extra leverage in close quarters.

DROP HANDLE—similar to the slide handle except it folds down when not in use.

WING NUT HANDLE—for open areas where a firm, two-handed grip is possible.

BASES



ROUND BASE—cored pocket to fit on standard or extra strong pipe, with 7/16" diameter hole to fasten fitting to pipe. Use with ⅜" diameter bolt.

ROUND FISHTAIL BASE—cored pocket to fit standard or extra strong pipe, with 7/16" diameter hole to fasten fitting to pipe. Use ⅜" diameter bolt. End grooved to fit over 1½" diameter pin.

SQUARE FISHTAIL BASE—cored pocket to fit over end of square tubing, with 7/16" diameter hole to fasten fitting to pipe. Use with ⅜" diameter bolt. End is grooved to fit over 1½" diameter pin.

MR-8 or MR-8-P (Capacity 8 tons)
MR-16 or MR-16-P (Capacity 16 tons)

Minimum Height Closed	Maximum Height Open	MR-8 Weight Pounds	MR-16 Weight Pounds
30"	45"	31	45
36"	51"	33	48
42"	57"	34	51
48"	63"	36	54
54"	69"	38	56
60"	75"	40	59
66"	81"	42	62
72"	87"	43	65

PIPE NOT FURNISHED

Jack No.	Capacity Tons	Screw Dia Inches	Screw Raise Inches	Pipe Column to be used
MR-80 or MR-80-P	8	1½	15	2" Standard
MR-160 or MR-160-P	16	1⅝	15	2" Extra Strength

Heights given are for type "B" heads. For other heads deduct 2" on MR-8 models, 1½" on MR-16 models. MR-8 screws are 1½" diameter. MR-16 screws 1⅝" diameter.

Write for Bulletin AD10—

"A Handy Guide for Selecting Mine Jacks."

Duff-Norton Company

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

AMERCLAD
PORTABLE POWER CABLE
types W and G

Amerclad power cable is extremely flexible, and will withstand continual reeling on and off drums. Because of its light weight and great toughness, it is widely used for electric shovels, dredges, cranes, excavating machinery and similar equipment.

Type W is recommended for potentials up to 2000 Volts. It has no shielding or ground wires. Type G is good for 5000 volts. When rated over 2000 volts, the insulated conductors are shielded with PS nonmetallic shielding, and all type G cables contain ground wires.

AMERCLAD
LOCOMOTIVE GATHERING CABLE

This single-conductor cable is especially designed for gathering-reel type electric mine locomotives. Standard conductors are copper, but they can be furnished with steel wire reinforcing for greater tensile strength. Copper conductors, on the other hand, withstand kinking better and they are easier to splice.

The cable is reinforced with tough seine twine and the flame-resistant Amerprene jacket is lead-sheath vulcanized.

AMERCLAD
PORTABLE CORDS
types SO and SJO

These cords are identical except that type SO has a heavier jacket. This cord is extremely flexible and is designed for use with portable tools and appliances. The tough Amerprene jacket is highly resistant to oil, grease and water. Many different types of cord construction are available.

AMERCLAD
2-CONDUCTOR ROUND MINING CABLE

The color-coded conductors are insulated with a heat-resisting rubber compound, then twisted and covered with a reinforced oil-resistant Amerprene jacket. Interstices between conductors are filled with neoprene.

The jacket is flame-resistant and can withstand tremendous abuse in all kinds of weather.

AMERCLAD
TWIN PARALLEL MINING MACHINE CABLE
types W and G

Compared to two-conductor round cables, Twin Parallel cables occupy less space on a reel or drum, and are lighter in weight. They are recommended for use up to 600 volts.

Sizes #1 and smaller feature the AS&W "bridge-wall" construction. This is literally a bridge of neoprene between the two insulated conductors and the ground wire. The "bridge-wall" construction enables this cable to withstand crushing weight and severe abrasion without service interruption.

AMERCLAD
WELDING CABLE

The tremendous number of extremely fine copper wires in this cable provide an unusual degree of flexibility. The cable lies flat without kinking or snarling and there is no undue strain on the operator's wrists. A separator is applied between copper and rubber, so it is easy to strip the insulation to make a splice.

3 great Tigerweld Bonds

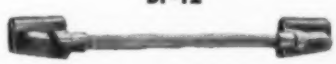
WEDGE-TYPE

The Tigerweld Wedge-Type Bond is primarily designed for quick installation on tracks that may have to be moved, but this durable bond holds so well that many mines use it for permanent installation. It can be installed in a few minutes with a high speed drill and a 3-pound hammer. In spite of its ease of installation, the wedge-type bond holds with a grip that won't shake loose. But if you want to remove the bond from temporary trackage, you can hammer it out as easily as you put it in.

BF-10

The Tigerweld BF-10 has self-clamping terminals to make installation easy. The terminals can be secured to the rails by a few taps of a hammer. And they stay firmly in place while the steel-to-steel weld is made. The BF-10 has great resistance to fatigue stresses. It can be reclaimed and used again and again.

BF-12



The Tigerweld BF-12 Bond is designed for quick, permanent low-resistance installation by welding. Just drive it on the base of the rail and it stays in position ready to weld. No special clamp is necessary. Your maintenance crews can install more bonds per day at lower cost. And once the BF-12 Bonds are installed they're on to *stay!*

All of these bonds are butt-welded. That means that in every case all the wires are electrically connected—permanently—to the solid end piece. Butt-welding will consistently develop almost full strength of the strand on a tensile test to destruction. So always specify Tigerweld Bonds. They're *all* butt-welded!

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION

General Offices: Rockefeller Building, Cleveland 13, Ohio

SALES OFFICES

BOSTON	Statler Building	KANSAS CITY	Power & Light Building
BUFFALO	Liberty Bank Building	MILWAUKEE	Bankers Building
CHICAGO	208 So. La Salle Street	NEW YORK	71 Broadway
CINCINNATI	Fifth-Third Bank Building	PHILADELPHIA	Suburban Station Building
CLEVELAND	Rockefeller Building	PITTSBURGH	525 William Penn Place
DENVER	First National Bank Building	ST. LOUIS	1221 Locust Street
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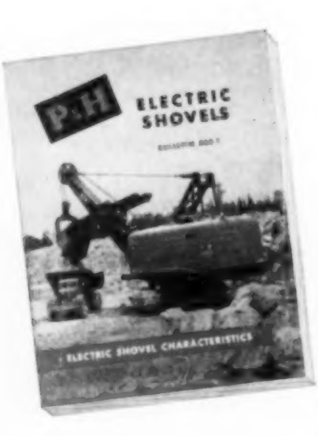
UNITED STATES STEEL EXPORT CO., 30 Church St., New York, N. Y., Export Distributors

USS

UNITED STATES STEEL

Why is **P&H** *at the head of the Big Three?*

MAGNETORQUE* and ELECTRONIC CONTROLS give operators the only modern electric shovels



For a clearly illustrated description of Magnetorque* and how it sets a new standard for electric shovel design and operation, write for Bulletin X-156. Other booklets available on electric shovel models from 3 to 10 cu. yd. capacity. A copy of these publications will be sent those who request it on their company letterhead.

These revolutionary advances in design and performance of electric shovels are just two of the reasons why operators and owners are pointing to P & H for their outstanding achievement in electric shovels . . . why P & H now is at the head of the Big Three . . . why P & H can promise you the only modern electric shovel.

Just think! Power transmission *without friction's* in massive electric shovels. Boosts efficiency. Cuts maintenance and operating costs. *This is Magnetorque.* Exclusive with P & H.

Just think! Complete control of dig, hoist, swing and propel of these giants with simple stepless control. 12% faster cycles; 16% savings in operating time. *This is Electronic Control.* Exclusive with P & H.

For complete information, call your P & H representative. Electric Shovel Division, Harnischfeger Corporation, Milwaukee 46, Wisconsin.

**T. M. of Harnischfeger Corp. for Electro Magnetic Type Coupling*

For Modern Engineering, Look to

HARNISCHFEGER

P&H ELECTRIC SHOVEL DIVISION

238 ft. per hour—

the kind of record that you make with the Reich

ANY-Speed

You see here a rig that just put down 24 holes for a total of 855 feet in 3 hours 36 minutes in sandstone and shale — not easy drilling. And other Reichs have drilled considerably faster.

Such outputs have now been made possible, by the new

Reich **INFINITELY VARIABLE** Drill Speed

with Diesel Power and Hydraulic Drive

Now an experienced driller can hit the *exactly right* speed for any material he's going through, from hardest to softest.

This is one more of the many Reich "firsts", by the same engineers who built the first successful top-drive hydraulically powered rotary air drill . . . the first rig that saves your time by drilling *up* in case of a rockfall into the hole . . . besides leading the way with other big improvements year after year.

And more still coming. When you buy a Reich, you get **the Rotary that's best TODAY.**

It's also the most dependable, because it has been perfected by our experience in building far, far more top drive rotaries than anybody else.

How about a demonstration on your own work? Or maybe you would prefer to get more facts about these new Reich Rotaries. Write, wire or phone —

REICH BROS. MFG. CO.
1439 Ash Street • Terre Haute, Indiana

Yes, you're looking at the fastest drill built—a Reich 700H45, with 50-foot drill stem — can drill 47 feet before swiveling another drill stem section into place. Can put more than 35,000 pounds down-pressure on the drill bit. Holes up to 9 inches.

We build the size and weight that you need — a

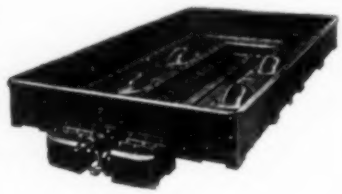
It will pay you to buy what **REICH** *has for you* **NOW**

(You'll out-drill the machines being built

ENTERPRISE WHEEL & CAR CORPORATION

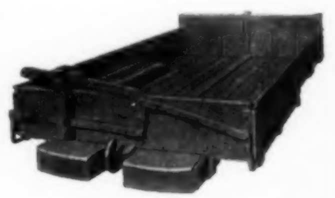
CUSTOM - ENGINEERED MINE CARS . . . . .

ENTERPRISE CARS are built for the mine—*not for the shop*



ENTERPRISE CARS are built to meet *every* mine specification

ENTERPRISE CARS give you *constant haulage* . . . no serious production delays. Repairs will not affect over-all mine operation



ENTERPRISE WHEELS are not made of ordinary cast iron. Enterprise wheels are made of chilled semi-steel—heat-treated for high tensile strength and shock resistance

ENTERPRISE TRUCKS can be furnished with either straight, tapered or ball bearings. In orders and inquiries, please include information regarding style truck, diameter of wheel and axle, track gauge, and wheel base

Your insurance against haulage delays and shut-downs . . . .
. . . MINE CARS

An experienced mine car engineering and production organization, backed by 57 years' experience, is at your disposal. Write us your haulage requirements and problems.

ENTERPRISE

WHEEL AND CAR CORPORATION
BRISTOL, VIRGINIA - TENNESSEE
HUNTINGTON, WEST VIRGINIA

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Lean
On
Us

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use our specialists in — — —
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Technical Writing Service*
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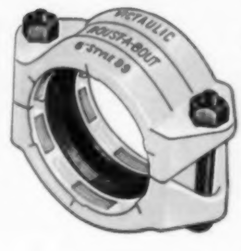
VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...

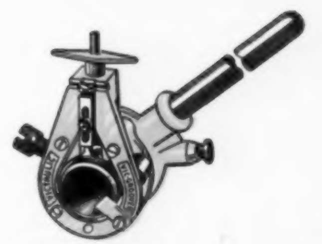


VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 8".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB



VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, a com*plete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".

VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 55-H.

VICTAULIC COMPANY OF AMERICA
P. O. BOX 509 • Elizabeth, N. J.

No.1

STAMLER LEADS IN ITS FIELD

You can look to the Leader for Loading Point Equipment that gets the Coal out Fastest And Most Economically!

STAMLER
LOADING POINT
EQUIPMENT

The **STAMLER**
Heavy Duty
CAR SPOTTER

The **STAMLER**
Automatic
LOADING STATION

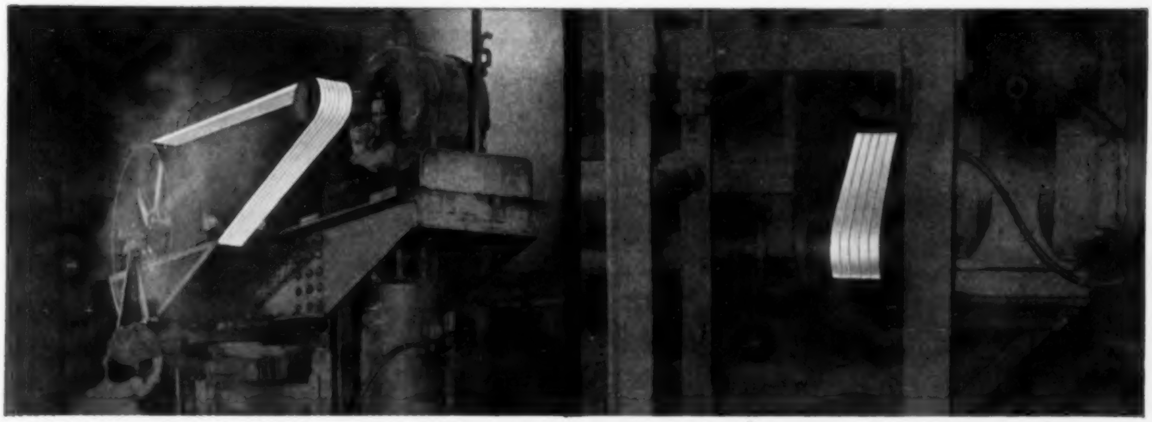
The **STAMLER**
"Shortie"
CAR SPOTTER

★ HYDRAULIC
★ AUTOMATIC
★ TESTED
★ PROVEN

WHEN any product reaches the No. 1 spot in its field, there is always a good reason. Here, the reason is simple — *STAMLER equipment gets the coal out faster, more efficiently and at less cost!* The STAMLER Hydraulic CAR SPOTTER, *which has been in use twice as long as any other,* will eliminate lost time at the loading point. Combined with the STAMLER Hydraulic AUTOMATIC LOADING STATION, your cars will be loaded automatically, uniformly and without spillage. Smart mining men have found that no other equipment can match the trouble-free performance of STAMLER equipment! *That's what makes STAMLER No. 1.* They try STAMLER equipment and they are completely satisfied that they have purchased the best. *Then they re-order!* This confidence, expressed by repeat orders, has sky-rocketed STAMLER sales to the point where the total 1955 sales (a very satisfactory year) were surpassed in 1956 by the end of March! *Get the STAMLER story!*

W. R. STAMLER CORP. PARIS KENTUCKY

SCHROEDER BROS., *Exclusive Eastern Sales Agent,* PITTSBURGH, PA.
UNION INDUSTRIAL CORP., CARLSBAD, NEW MEXICO · SALMON & CO., BIRMINGHAM, ALA.



Intense heat no problem for Super Belts

This hydraulic press at Hackney Iron and Steel Co., Enid, Oklahoma, shapes red hot steel plate into tank heads.

The flat leather belt formerly used on this type of press, would stretch, slip, and come off. Tightening the belts only overloaded the bearings. For this press, a Gates Super Vulco Rope drive was chosen because it withstands the near-by intense heat, and its extra horsepower capacity permits lighter weight sheaves; thereby reducing load on bearings.

Claude King, maintenance superintendent, reports: "This Gates V-belt drive has operated 8 hours a day for 5 years without lost time due to maintenance."

Super Belts on vibrator last 7 times longer

James Gann, general superintendent of John B. LaGarde, Inc., Anniston, Alabama, reports:

"Practically every condition exists to shorten V-belt life on the vibrator drive of this concrete block machine. The machine starts and stops 4 times a minute. Intense vibration must be absorbed by the V-belts to protect motor and bearings. Sand and concrete, oil and grease all get into the drive.

"With Gates Super Vulco Ropes, we get about 7 times the average life we received from any other make, It is hard to believe that belts can take this punishment, but Gates Super Vulco Ropes do it."

Solve tough drive problems with this super tough V-belt

If present V-belts are wearing out too fast . . . if heavy shock loads . . . oil and heat . . . or other conditions are causing too frequent replacement . . . here's the answer:

Gates Super Vulco Rope—the oil and heat resistant V-belt with 40% more horsepower capacity. Easily handles heavy shock loads.

That means longer V-belt life and *cost savings two ways*—savings on belt replacements and savings on maintenance down-time.

Let a Gates V-Belt specialist help you solve *any* tough drive problem. He'll make recommendations without obligation. Gates offices and distributor stocks are listed in the phone book yellow pages in all major industrial centers. The Gates Rubber Co., Denver, Colorado—*World's Largest Makers of V-Belts.*

The Mark of Gates *Specialized Research*

TPA 104

Gates SUPER VULCO ROPE Drives

MODERN HAULAGE FOR MODERN MINING!

RUBBER TIRE AND TRACK MACHINES FOR EVERY PURPOSE!

MODEL 444-G. New version of our well-known Model 444 4-wheel-drive, 4-wheel-steer tractor, with improved drive line, steering and brakes. High drawbar pull makes it ideal for larger-tonnage mines with bed bottom. Short turning radius. Length 10'-6", width 64", height 24", weight 4000#. Disc brakes, gearmotor drive. Battery in two quick-change steel trays.

MODEL 444-E. Largest, most powerful tractor available. 4-wheel-drive, 4-wheel-steer. Ideal mainline tram for any smaller mine with long hauls, steep grades, low top. For conveyor mines, the best machine for hauling men and materials. Length 12', width 74", height 24", weight 8000#. Enclosed gearmotor drive, contactor control. Long-life battery in two quick-change trays.

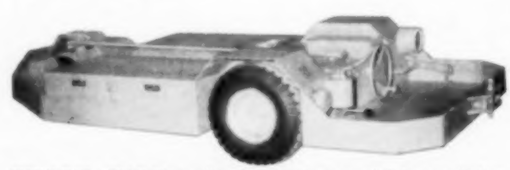
MODEL 2916. One of our line of locomotives, this model has gearmotor and chain drive, mechanical band brakes, 2-speed oil-immersed drum controller, anti-friction bearings throughout. Battery in 2 quick-change steel trays. Height 29", weight 7600 pounds. Locomotives can be furnished in heights as low as 20", any track gauge.

MODEL PC-8. A new addition to our line of utility vehicles, the PC-8 with enclosed gear motor drive and 12 K.W.Hr. battery is ideal for men and materials. The rear cargo deck will accommodate a stretcher, mechanics tools, greasing equipment or drilling equipment up to 2000 pounds capacity. The PC-8 can also double as a Tractor for towing supply trailers. Length 13'8", width 72", height 24", weight 4000#.

MODEL 60 — TANDEM COAL CAR. Capacity approx. 2 tons. Spec., width 66", length 11', height 16" overall with a 6" ground clearance.

MODEL 55-B — TANDEM COAL CAR. Capacity approx. 2 tons. Spec., width 60", length 10', height 19" overall with a 6" ground clearance.

MODEL 55-BD — BOTTOM DUMP COAL CAR. Capacity approx. 2 tons. Spec., width 60", length 10', height 19" overall with a 6" ground clearance.



"NEW." The HT-8 three-wheel Tractor is a completely new design with Heavy Duty traction type gear-motor with drive-shaft to differential. No chains or sprockets. Length 11', width 62" height 24", weight 3800 lbs., contactor control, heavy duty 4000 lb. differential, ball bearing steering gear housing, rear axle spring mounted and sealed beam lights.

A. C. Selenium Rectifiers available for single phase and three phase power.

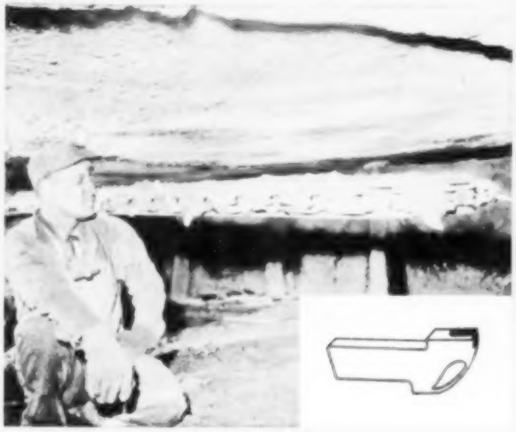
KERSEY
MINE HAULAGE EQUIPMENT

NOW! Motive power batteries with 50% additional capacity available as optional equipment on all tractors.

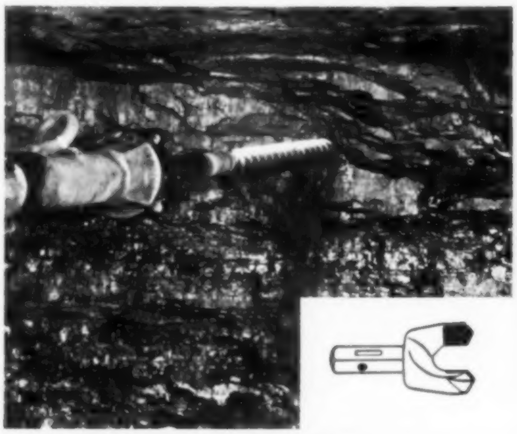
KERSEY MANUFACTURING CO., INC.

P. O. Box 151, BLUEFIELD, VIRGINIA, Phone 4228

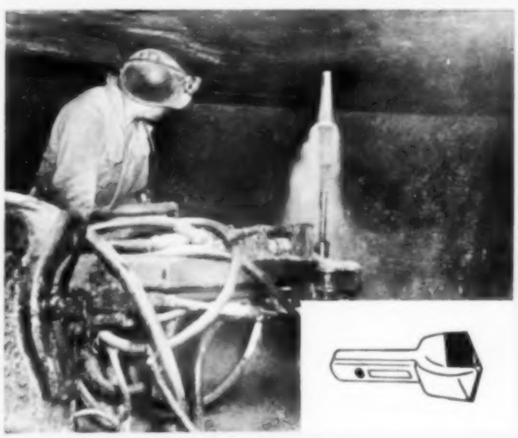
THERE IS A KENNAMETAL BIT FOR EVERY MINING OPERATION



Cutter Bits



Bits for Auger Drilling



Bits for Roof Drilling

KENNAMETAL*

MINING TOOLS

for cutting... for drilling

no other carbide lasts so long...
needs so little reconditioning...
causes so little strain on equipment...
costs so little per ton

Tool performance is measured best by the bit cost per ton. Cost is the end result of the quality of the bit. Kennametal bits are always of top uniform quality *because* Kennametal is able to maintain constant, rigid quality control of every step in the production of tungsten carbide bits from the moment ore is mined through each complex phase of refining the ore and of manufacturing the bits.

INDUSTRY AND

KENNAMETAL

...Partners in Progress

*Registered Trademark

IT WILL PAY YOU TO TRY KENNAMETAL BITS IN YOUR MINING OPERATIONS

AVAILABLE

A KENNAMETAL

KENNAMETAL Cutter Bits

KENNAMETAL Mining-Machine BITS combine hard, cemented carbide cutting edges with a bit body of the highest quality steel, heat-treated to the correct hardness for machine operation. Special design and tough shank construction provide top coal cutting efficiency at higher speeds, with exceptionally long service life. Self-gaging prevents the bit from being driven down into the machine bit block. Savings in production time, fewer bit changes, lower power consumption, less machine maintenance add up to reduced cost per ton of coal. Ask your local Kennametal Representative to show reports of top performances enjoyed by coal operators everywhere with Kennametal Cutter bits.

Catalog Number	Dimensions			
	Gage	X	Y	L
U1	1½"	½"	1"	3⅝"
U1H	1½"	½"	1"	3⅝"
U4	1¾"	½"	1"	3⅞"
U4H	1¾"	½"	1"	3⅞"
U7	1¾"	½"	1"	3⅞"
U8	1½"	½"	1"	3⅝"
U9	1⅝"	⅞"	1 3/16"	3 7/16"
U10	1¾"	½"	1"	3⅞"
U11	1½"	½"	1"	3⅝"
U1R	1½"	½"	1"	3⅝"
U4R	1¾"	½"	1"	3⅞"
U6R	2½"	¾"	1¼"	3⅝"
U7R	1¾"	½"	1"	3⅞"
U8R	1½"	½"	1"	3⅝"
U9R	1⅝"	⅞"	1 3/16"	3 7/16"

KENNAMETAL Drill Bits

Designed especially for drilling both coal and rock, Kennametal Drill Bits provide long drilling life at low cost per ton. Even in successive layers of boney, clay, slate, shale and other hard impurities, the sintered carbide cutting edge withstands hard, tough service. And drilling can be continued for several shifts under average conditions, without time off for bit changing. Other features of Kennametal Drill Bits include fast chipping action, a rapid rate of penetration, and a smooth flow of cuttings.

Catalog Number	Dimensions		
	D	H	L
RD-1⅛	1¼"		
RD-1⅜	1⅜"		
RD-1½	1½"		
RD-1⅝	1⅝"		
RDC-1⅝		½" sq.	2"
D-1¾	1¾"		
DC-1¾			
D-1⅞	1⅞"		
DC-1⅞			
DS-1⅞	1⅞"	5/16" sq.	1½"
DD-1⅞	1⅞"		
DDC-1⅞			
DD-2	2"	⅝" sq.	2¼"
DDC-2			
DD-2¼	2¼"	⅝" sq.	
DDC-2¼			

Catalog Number	Dimensions		
	D	H	L
DB-2¼	2¼"	13/16" Hex.	
DD-2½	2½"	⅝" sq.	2¼"
DDC-2½			
DB-2½	2½"	13/16" Hex.	
DBC-2½			
DB-2¾	2¾"	13/16" Hex.	
DBC-2¾			
DB-3	3"	13/16" Hex.	2¼"
DBC-3			
DBB-3	3"	1⅛" Hex.	3"
DBBC-3			

Styles DL and DBL are available in the same sizes and shank styles D and DB Bits, from 1¾" to 3".

KENNAMETAL Roof Bits

The design of Kennametal roof drilling bits and the selection of carbide grades for this service make possible the use of high thrust and torque to get holes through rock of various degrees of hardness and toughness without fracture of the cutting edges. Water ports are provided for cases where wet drilling is used. For more refractory work, Kennametal rock bits are supplied for use with stopers.

Catalog Number			Dimensions		
Style FDH	Style FDL	Style DK	D	H	L
FDH-1¼	FDL-1¼		1¼"		
FDH-1 5/16	FDL-1 5/16		1 5/16"		
FDH-1⅜	FDL-1⅜	DK-1⅜	1⅜"		
FDH-1 7/16	FDL-1 7/16		1 7/16"	½" sq.	2"
FDH-1½	FDL-1½	DK-1½	1½"		
FDH-1⅝	FDL-1⅝	DK-1⅝	1⅝"		
FDH-1¾			1¾"		
FDH-1⅞			1⅞"		
FDDH-1⅞			1⅞"		
FDDH-2			2"	⅝" sq.	2¼"
FDDH-2¼			2¼"		
FDBH-2¼			2¼"	13/16" Hex.	

THERE IS A COMPLETE LINE OF KENNAMETAL CUTTER BITS,

BIT FOR EVERY MINING NEED...

Style U10

Style U7R

Style U8

Style U4H

Style U9R

Style D

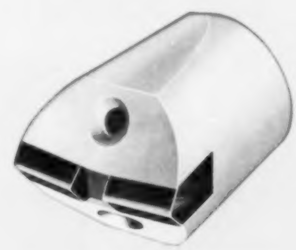
Style DC

Style DB

Style DL

Style FDH

Style FDL



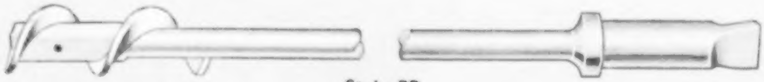
Style PA

DRILL BITS, ROOF BITS, AUGERS, PINNING RODS, ACCESSORIES

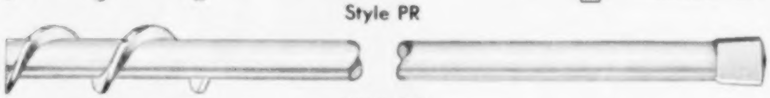
KENNAMETAL SPECIALTIES AND ACCESSORIES

KENNAMETAL Pinning Rods

These Pinning Rods are of special design to make roof bolting more practical wherever standard drills are used. Generally, the rod shanks are of the twist type to fit regular Kennametal Drive Sockets, but square and other types are made for special applications.



Style PR



Style PRF

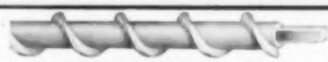
PR Rods with Twisted Shank		PRF Rods with 1 1/8" Square Shank		PRSB Rod (Extension) 1/2" Square Shank	
Rod Length	Cat. No.	Rod Length	Cat. No.	Rod Length	Cat. No.
2′	PR 13-2	2′	PRF 13-2	1′	PRSB-1
3′	PR 13-3	3′	PRF 13-3	2′	PRSB-2
4′	PR 13-4	4′	PRF 13-4	3′	PRSB-3
5′	PR 13-5	5′	PRF 13-5		
6′	PR 13-6	6′	PRF 13-6		

Other lengths in 6" multiples available. All types available with no scroll on request.

KENNAMETAL Augers

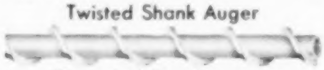
These augers are made of the highest quality steel available, giving them great strength and maximum resistance to bending. Life of the scroll is greatly increased by flame hardening during fabrication. Available styles of shanks: twist, threaded, and snap-button types. Smaller diameter augers have solid centers, while the larger diameters are tubular.

Also Kennametal Sockets, Studs, Couplings and Adapters.



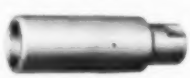
Snap-Button Shank Auger

Twisted Shank Auger



Threaded Shank Auger

Style BR Socket



Snap-Button Shank Augers

Cat. No.		Dimensions	
3" long	4" long	D	C
SB13-3	SB13-4	1 5/16"	1/2" sq.
SB14-3	SB14-4	1 1/2"	
SB16-3	SB16-4	1 3/4"	5/8" sq.
SB20-3	SB20-4	2"	
SB24-3	SB24-4	2 1/2"	

Twist Shank Augers*

Auger Length	Cat. No. D = 1 5/16" C = 1/2"	Cat. No. D = 1 1/2" C = 1/2"	Cat. No. D = 1 3/4" Standard	Cat. No. C = 5/8" H.Duty*	Cat. No. D = 2" C = 5/8"	Cat. No. D = 2 1/2" C = 13/16" Hex.
3 ft.	A13-3	A14-3	B16-3	BB16-3	B20-3	H24-3
4 ft.	A13-4	A14-4	B16-4	BB16-4	B20-4	H24-4
5 ft.	A13-5	A14-5	B16-5	BB16-5	B20-5	H24-5
6 ft.	A13-6	A14-6	B16-6	BB16-6	B20-6	H24-6
7 ft.	A13-7	A14-7	B16-7	BB16-7	B20-7	H24-7
8 ft.	A13-8	A14-8	B16-8	BB16-8	B20-8	H24-8
9 ft.		A14-9	B16-9	BB16-9	B20-9	H24-9
10 ft.			B16-10	BB16-10	B20-10	H24-10
Bit Sizes	RD-1 3/8 RD-1 1/2 FDH-1 3/8 FDH-1 7/16 RD-1 1/2	FDH-1 5/8 RD-1 5/8 D-1 3/4 D-1 7/8	DD-1 7/8 DD-2	DD-1 7/8 DD-2	D-2 1/4 D-2 1/2	DB-2 3/4

*Special Heavy-Duty Auger for use with high-powered drills. Augers with threaded couplings for long hole drilling are obtainable in the 16, 20, and 24 series by using the auger number above and specifying Acme threads and connecting stud CSA, and shank TRCSA.

H Augers (Hexagonal Chuck) are available for DB Bits.

Special Drill Series

Kennametal *Style FS* Finger Bits provide exceptional stamina and speed in drilling large diameter holes in hard rock.

The Kennametal Style SD bit is a three-pronged bit used in sizes from 3 3/4 to 9-inch diameter for drilling holes to blast overburden and for other special uses. The UD bit, for similar applications, uses replaceable cutters.

Style FS

Style SD

Style UD

INDUSTRY AND KENNAMETAL ...Partners in Progress

Mining Tool Division, Bedford, Pennsylvania
General Offices and Main Plant, Latrobe, Pennsylvania

YOUR KENNAMETAL REPRESENTATIVE IS LISTED IN THE CLASSIFIED TELEPHONE DIRECTORY UNDER MINING EQUIPMENT AND SUPPLIES

Form BM-101

FOR **HIGH PRODUCTION** AND **LOWEST OPERATING** COSTS—

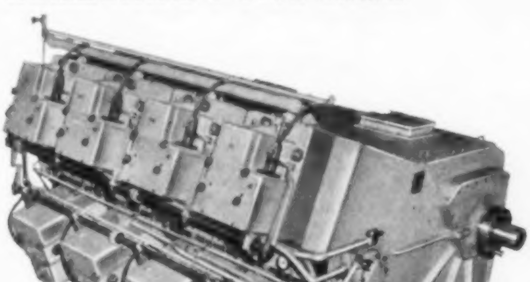
NOTHING equals the PAGE 700

SERIES

SINGLE DECK WALKING DRAGLINE

3 models
5 to 15 cubic
yard capacities

Powered by the
DRAGLINE-PROVED PAGE
HORIZONTAL V-TYPE DIESEL



The Page Engines powering 700 Series Draglines are designed specifically for dragline work . . . to work longer, at lower cost, with less downtime and maintenance than any other engine. Big bearings, big pistons, a short, stiff crankshaft and slow (450 RPM) speed are only part of the story of why many Page Diesels are still producing maximum horsepower after 20 years of operation. Bulletin WDSD-155 has full details.

Page 700 Series Draglines are rugged, compact, workhorse machines. They are designed and built with the fastest practical hoist and swing speed to reduce cycle time and increase yardage.

The Page 700 Series Dragline is proof that a fast, efficient, medium-sized machine will *consistently* outperform larger, but slower machines in virtually every kind of digging.

In addition, initial investment for a Page 700 Series Walking Dragline is considerably smaller, and operating and maintenance costs are lower. *Want more details? Write for Bulletin WDSD-155 today. There's no obligation.*

PAGE ENGINEERING COMPANY
CLEARING P. O.—CHICAGO 38

Page

Automatic Dragline
Buckets
Walking Draglines

W-2001

If it's a PAGE... *It* DIGS

IT PAYS TO *Specify*

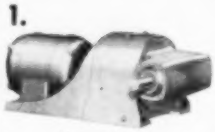
FALK DRIVES and COUPLINGS

- A wider choice of standard designs
- Practical features exclusive to Falk
- Sound, progressive engineering
- In-built factors for long, efficient service

1.

Motoreducers
All-Motor Horizontal

1.



Motoreducers
All-Motor Right Angle

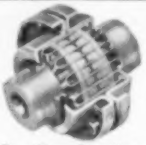
1.

Motoreducers
All-Motor
Vertical

2.

Shaft Mounted
Drives

3.

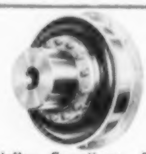


Steelflex Couplings
Standard or Dual Purpose

3.

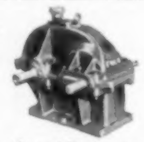
Large Steelflex Couplings
for Heavy Duty Service

4.



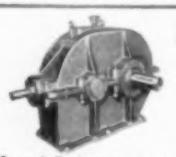
Airflex Couplings—For
High Torque Fluctuations

5.



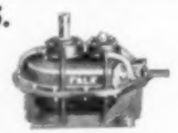
Speed Reducers
Large Parallel Shaft

5.



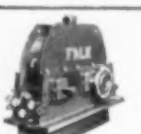
Speed Reducers—Large
Right Angle Horizontal

5.



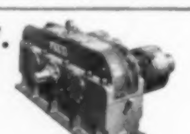
Speed Reducers—Large
Right Angle Vertical

6.



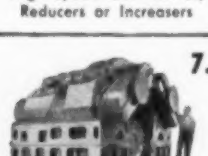
High Speed Gear Drives,
Reducers or Increasers

7.



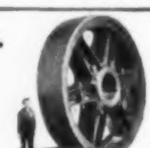
Special Gear Drives
for Any Application

7.



Marine Propulsion Gears,
Turbine or Diesel Driven

8.



Helical Gears—Any Size

You can rely on Falk for top quality engineering and craftsmanship. For more than half a century, Falk engineers and production men have specialized exclusively in the design and manufacture of quality drives and couplings. This accumulation of experience and continuous research has produced a line of products noted for mechanical efficiency, long life, and progressive, practical design . . . products which have earned for Falk a good name in industry throughout the world.

1. **Motoreducers** . . . The famous All-Motor Motoreducer uses any standard foot-mounted motor within the capacity of the gear unit. All-steel construction; helical gearing. Horsepower range from 1 through 75 hp. Output speeds: concentric shaft design — from 1.8 to 580 rpm; right angle shaft design — from 1.2 to 350 rpm. Ratios up to 54,000:1 in special units. Integral design also available, from 1 through 40 hp.

2. **Shaft Mounted Drives** . . . A variation of the Motoreducer design, adapted for mounting on shaft to be driven, using V-belt connection to motor. All-steel construction, helical gearing. Single or double reduction units in six sizes. Horsepower range from 1 through 30 hp. Output speeds from 420 to 10 rpm. Offset shaft design provides means for adjusting belt tension by using turnbuckle on tie-rod.

3. **Steelflex Couplings** . . . Exclusive grid-groove design smothers shock and vibration, accommodates reasonable degrees of shaft misalignment and free end float. The basic Type F is applicable to more than ninety per cent of all industrial applications, horizontal or vertical. Thirty-three sizes to cover capacities from 2/5 through 70,000 hp per 100 rpm (basic rating). Special or dual purpose Steelflex designs available for problem applications. Almost a million Steelflex couplings have gone into industrial service.

4. **Airflex Couplings** . . . Protect machinery against damage from impacts resulting from irregular torque characteristics of prime mover or driven machine. Require no maintenance. Provide electrical insulation between machines. Dual purpose types for problem applications.

5. **Speed Reducers** . . . Falk precision cut helical or spiral bevel gears produce highest attainable mechanical efficiencies. Sturdy housings, liberal bearing capacities, positive lubrication. ***Concentric Shaft Reducers:*** from 1 through 150 hp; ratios from 1.5:1 to 970:1. ***Parallel Shaft Reducers:*** from 15 through 3000 hp; ratios from 2:1 to 300:1; sleeve or roller bearing units. ***Small Right Angle Reducers:*** horizontal or vertical output shaft; from 1 through 150 hp; ratios from 5:1 to 1450:1. ***Large Right Angle Reducers:*** with horizontal output shaft — from 15 through 1000 hp, with ratios from 1.5:1 to 515:1; with vertical output shaft (up or down) — from 15 through 700 hp with ratios from 6:1 to 430:1.

6. **High Speed Drives** . . . For use as reducers or increasers. Quiet operation, high efficiency. Standard units: horsepower range through 5000 hp; maximum speeds ranging from 4500 to 9000 rpm. Special designs: horsepower ratings through 21,500 hp and higher; output speeds above 50,000 rpm, if required.

7. **Special Gear Drives** . . . Falk engineering experience and complete production facilities have designed and produced gear drives for almost any application . . . from sturdy, slow speed mill drives . . . to large marine propulsion drives . . . to ultra high speed drives.

8. **Single Helical or Herringbone Gears** . . . For any application. Hub gears, ring gears, mill pinions. Precision cut, Falk improved tooth form. Face widths up to 6 ft or more. Diameters up to 18 ft. Gears made of Falk alloy steels; pinions made from steel forgings. Full load efficiency of 98% per train.

THE FALK CORPORATION

3057 W. Canal Street, Milwaukee 1, Wisconsin

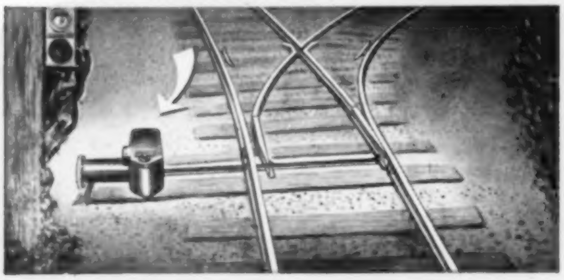
REPRESENTATIVES AND DISTRIBUTORS IN MOST PRINCIPAL CITIES

Magic Performance

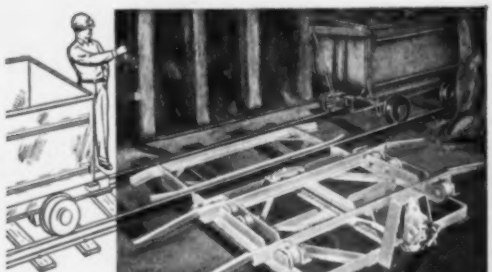
PILES UP SAVINGS...

When you are expected to pull profits out of your hat, just turn to American Mine Door profit-making equipment.

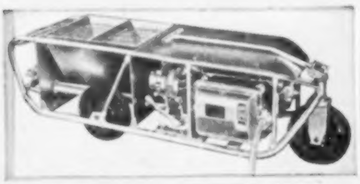
"Canton" Track Cleaners
Model 30 designed for low coal . . . Model 40 for the average mine. Keep road beds clean, saving thousands of dollars per month. Now rendering spectacular performance in coal, iron, copper, potash and salt mines . . . tailor-made to your specifications.

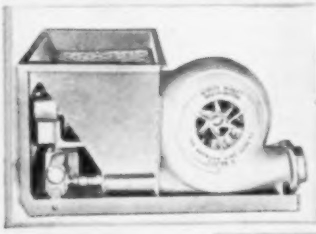


"Canton" dependable switch thrower
Make extra profits with extra speed. No jumping on and off trips . . . man hours, man lives saved . . . more tons taken out . . . greater profits per shift. Reliable "American Mine Door" mechanism.

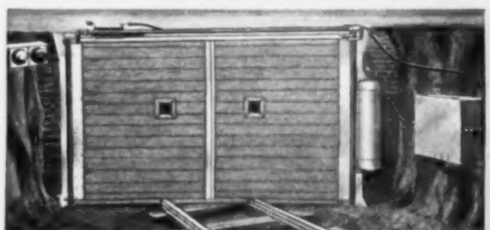


"Canton" Air Power Car Transfer
Now Air Power is added to the money-saving Car Transfer. One man does the work of three. Loads entire train on a single track. Less rib to shoot than for jump switch . . . no hazzards of cherry picker. Air Power now 50% faster. Can be installed on your present hand model.

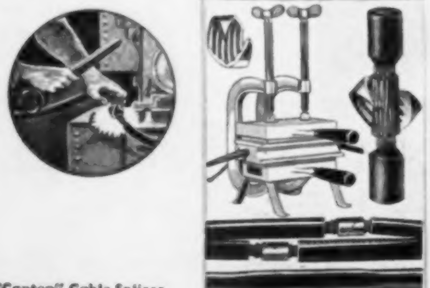




"Canton" Rock Dusters
"Canton" Little Chief goes anywhere . . . rubber tired model 22½" high, or skid model 18½" high, for shuttle buggies, belts or mine cars, or track-mounted for haulage roads. Delivers 34 to 60 lbs. dust per minute through 50 to 400 ft. 1¾" hose. "Canton" Mighty Midget weighs only 280 lbs. . . . quickly moved to dust rooms as soon as loading machine departs. Ideal for small mines . . . inexpensive, can be cart-mounted . . . big capacity . . . 7 tons per shift. (The Track Mounted Hi-Pressure "Dustmaster" is still the greatest Dustributor ever built, described in brochure.)



"Canton" Mechanically Operated Doors
First, the "Canton" mechanical door, not subject to power failure, famous for half a century . . . NOW the "Canton" Air Power Door with overhead operating equipment, BOTH effect tremendous savings by allowing full speed, profitable trips, eliminating accident potential of hand doors.



"Canton" Cable Splicer and Vulcanizer
"Canton" Cable Splicers are greatest reducer of down time. Every machine man should carry a pocketful. Just pound around cable and go on working. No special tools. Used with vulcanizer in shop makes new, smooth, snagless splice strong as original cable.

Half Century of Dependable Service

THE AMERICAN MINE DOOR CO.

2057 DUEBER AVE., CANTON 6, OHIO

We'll install "Canton" American Mine Door Products in your mine. Pay us out of increased profits. Write for complete brochures. Please use street and zone numbers.

The New York City Water Supply Co. uses these 2 yd. Lima Type 802's (above and at left below) to quarry rock near Neversink, N. Y. Lima quality really pays off in low downtime on tough digging jobs like this.

These LIMAS dig and load rock fast... and stay on the job day-in and day-out

It takes a really rugged machine to dig and load rock day-in and day-out. That's why thousands of users depend on Limas—like the Type 802, 2 yd. shovel shown here—to handle their toughest rock jobs. They know that Lima quality guarantees them the extra-rugged construction needed for high output, low downtime, money-making operation.

It will pay you to get the full story on the complete line of quality-built Limas. Find out today how you can get maximum performance and operating economy—with a Lima. See your nearby Lima distributor, or write Construction Equipment Division, Baldwin-Lima-Hamilton Corporation, Lima, Ohio.

COMPARE QUALITY! No other machine gives you as much as LIMA!

1. Piston-type dirt seal rings and retainers in crawler rollers.
2. Moving parts are flame or induction hardened for longer life.
3. Main machinery is placed well back of center of rotation.
4. Anti-friction bearings at all important bearing points.
5. Big capacity drums and sheaves are easy on cables.
6. Torque converter (optional).
7. Wherever you are, you can depend on skilled service and nearby warehouse stocks of parts to keep your LIMA on the job continuously.

COMPARE and you'll specify LIMA for shovels ($1/2$ yd. to 6 yds.), cranes (to 110 tons) and draglines (variable). Smaller capacities available on rubber.

DISTRIBUTORS IN PRINCIPAL CITIES OF THE WORLD

BALDWIN BLH LIMA-HAMILTON

LIMA SHOVELS · CRANES · DRAGLINES · PULLSHOVELS

BALDWIN-LIMA-HAMILTON

Construction Equipment Division — LIMA WORKS

OTHER DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Hamilton • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

COAL PREPARATION NEWS

Coal Fields Set Profit Records with DMS*

33 DMS INSTALLATIONS IN 2½ YEARS

More Than All Other Systems Combined

Map illustrates how demand for DMS Installations follows pattern of America's largest coal producing areas.

DMS is the only Coal Preparation System that can handle big tonnages and still operate at better than 99% efficiency. That's why so many leading coal producers are installing DMS Systems as the surest way to increase profits and production at the same time. They know there is no substitute for the precision preparation of a DMS Dense Media Plant.

By meeting the requirements of producer and buyer alike, DMS presents a 'foolproof' System for big tonnage production of easy-to-sell coal. There's no involved procedure—an entire 'push-button' controlled Plant can be operated by one man. Specific gravity level is automatic. Simplified, practical design provides lowest preparation costs in the industry.

Check on the DMS Installations listed below. It's easy to see why DMS is America's 'blue chip' Preparation System when you learn that one installation alone is paying for inself every 2 months in extra profits. For big production of premium priced coal—you can't afford to settle for anything less than DMS.

DMS Plants In Order of Completion

EASTERN KENTUCKY
2000 tons per day on Elkhorn No. 2 Seam
S. W. VIRGINIA
2500 tons per day on Taggart Seam
PENNSYLVANIA
2000 tons per day on Miller "B" Seam
PENNSYLVANIA
2500 tons per day on Miller "B" Seam
PENNSYLVANIA
2500 tons per day on Upper Freeport Seam
NEW YORK STATE
1000 tons per day of Garnet
WEST VIRGINIA
1600 tons per day on Sewell Seam
ALABAMA
2400 tons per day of Iron Ore

PENNSYLVANIA
2000 tons per day on Upper Freeport Seam
WEST VIRGINIA
3000 tons per day on Pittsburgh Seam
PENNSYLVANIA
2000 tons per day on A-B-C Seams
WEST VIRGINIA
3000 tons per day on Sewell Seam
VIRGINIA
2000 tons per day on Splashdam Seam
ILLINOIS
3000 tons per day on Illinois No. 5 Seam
WEST VIRGINIA
4950 tons per day on No. 5 Block Seam
PENNSYLVANIA
1000 tons per day of Limestone
WEST VIRGINIA
3000 tons per day on Pocahontas No. 3 Seam
ALABAMA
3000 tons per day on Mary Lee Seam
PENNSYLVANIA
2000 tons per day on Upper Freeport and Lower Freeport Seams
EASTERN KENTUCKY
3000 tons per day on Harlan Seam
VIRGINIA
1000 tons per day of Manganese

VIRGINIA
2500 tons per day on Pocahontas No. 3 Seam
EASTERN KENTUCKY
4000 tons per day on Harlan Seam
WEST VIRGINIA
3250 tons per day on Pocahontas No. 3 Seam
WEST VIRGINIA
3000 tons per day on Pocahontas No. 3 and No. 4 Seams
PENNSYLVANIA
500 tons per day of Silica
WEST VIRGINIA
3000 tons per day on Alma Seam
WEST VIRGINIA
3000 tons per day on Powellton Seam
VIRGINIA
3000 tons per day on Splashdam and Eagle Seams
PENNSYLVANIA
1000 tons per day on A and D Seams
WEST VIRGINIA
2500 tons per day on Pocahontas No. 3 and No. 4 Seams
WEST VIRGINIA
2800 tons per day on Pocahontas No. 3 and No. 4 Seams
KENTUCKY
2000 tons per day on Crockett Seam

Write For Complete Performance Data—FREE. Find out how to increase your own profits—arrange for an inspection of the DMS Plant nearest you.

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* REG. U.S. PAT. OFF. No. 623396

PENNSYLVANIA CRUSHER DIVISION

BATH IRON WORKS CORPORATION

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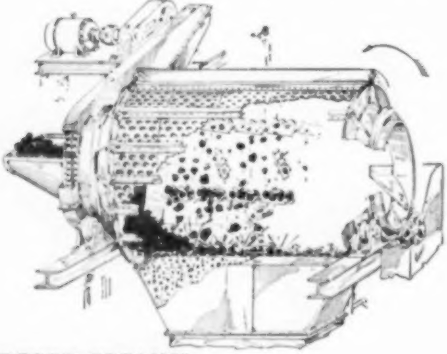
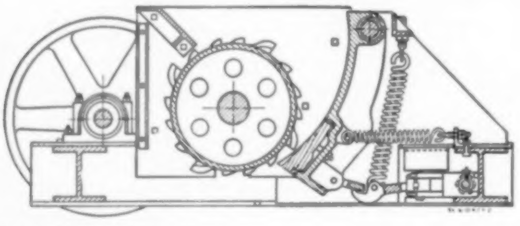
CRUSHERS FOR THE COAL INDUSTRY



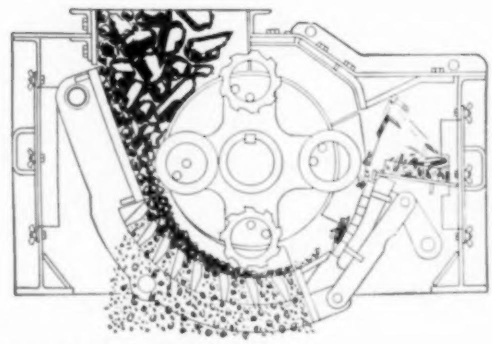
BRADFORD BREAKER

Conditions coal for cleaning, removes debris, eliminates oversize, produces uniform sizes with minimum fines and makes full seam mining practical and economical. Send for Bulletin No. 3008.



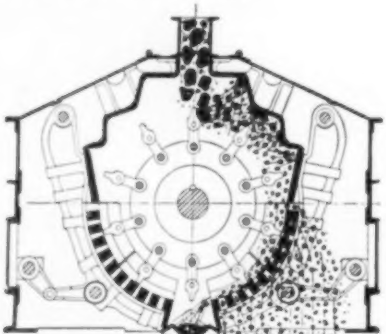
SINGLE ROLL

For reducing ROM hard and soft coals down to as small as 1" and under—crushing refuse at mines and cleaning plants—preparation of stoker coals. Send for Bulletin No. 2007.



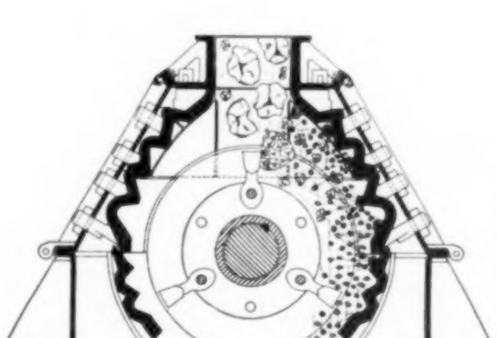
GRANULATOR

A ring type hammermill with a patented method of suspending the ring hammers to produce less fines than other hammermills. Ideal for preparing pulverizer and stoker coals and for crushing middlings. Cage assembly is ***adjustable,*** can be quickly moved either toward or away from the path of the crushing rings—***and the adjustment is positive!*** The operator compensates for wear simply by moving the cage assembly closer to the crushing rings, thus keeping desired clearance and getting a ***standard*** product throughout the Granulator's long working-part life. As the Granulator crushes, it ***automatically*** traps "out-law", iron and other metallics often present in ROM coal and other feeds. Too big to escape between the cage bars, and relatively uncrushable, this tramp iron and debris is thrown along by the crushing rings until it reaches the limit of the cage and falls into a "trap," or pocket, easily accessible through an inspection and maintenance door. Send for Bulletin No. 9003.



REVERSIBLE HAMMERMILL

For secondary reduction of coal to stoker size or finer. Since most of the crushing is done by impact and a minimum by attrition, this crusher delivers a uniform product at high reduction ratios with less overgrinding than any other hammermill known. Send for Bulletin No. 1040.



IMPACTOR

Reduction is by impact, no attrition, thus this crusher is ideal for low cost crushing of washery and mine refuse and for separating coal from bone and rock. Send for Bulletin No. 6017.

Does a trip of Mine Cars ever wear out?

No! Effectively, a mine car trip *never* wears out. When one car needs repairs, you simply shunt it to a siding in a couple of seconds...and the rest of the cars keep rolling out the tonnage. When you retire a car after a long, hard life, it's just one car, not a major over-haul. One car at a time over the years, a mine car trip is kept young and productive with ordinary maintenance and repair.

And **acf** Constant Haulage Mine Car Systems offer additional advantages. *Flexibility:* extending or changing your line is relatively simple when there's only track to move. *Two-way payloads:* men and supplies can ride into your mine in cars that carry the coal out.

Actual cost and production figures, supplied by mine operators, show the many advantages of **acf** Constant Haulage Mine Cars. Ask your **acf** Representative. Just write, wire, or phone any **acf** office.

AMERICAN CAR AND FOUNDRY DIVISION

acf Industries, Incorporated. *Sales Offices:* New York—Chicago—St. Louis — Cleveland — Washington — Philadelphia — Berwick — Huntington—San Francisco. *Plants:* Berwick, Pa.—Huntington, W. Va.

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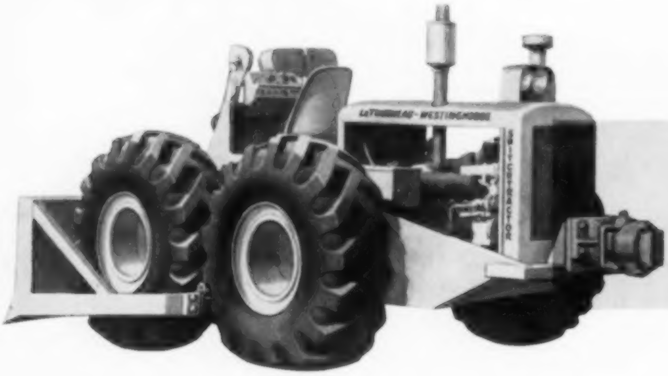
MINE CARS

for Constant Haulage



new switch for old rig!

SwitchTractor

Now . . . time-tested Tournatractor

When not needed for spotting or hauling rail-cars, fast-moving, double-duty SwitchTractor drives anywhere around pit or plant on dozing, maintenance, and clean-up chores.

Ten years' hard use has improved and perfected the fast, rubber-tired performance of this work-and-run Tournatractor. Thousands of these machines have proved their value in dozing, hauling, pushing, grading, scarifying, compacting, and snowplowing in practically every country of the world. Each year has seen many major improvements. Wherever speed and maneuverability are needed, these fast-moving rigs have given outstanding service.

Doubles value of Tournatractor

Now — with new *SwitchTractor* application — this versatile unit gives you added utility. Equipped with a standard railway coupler at the rear, SwitchTractor does double-duty on your location . . . switches freight cars on your siding, yard, or pit at a moment's notice. Rig has plenty of power and traction to pull and spot long trains of cars as needed, saving time and money.

SwitchTractor often eliminates the need for maintaining private switch engines and engineers . . . saves charges and delays for RR switch service. Your single SwitchTractor and operator may well handle all your scattered tractor-dozer work — plus whatever freight-

New double-duty SwitchTractor

Famous high-speed work-and-run tractor now available with standard railroad coupling attachment. Makes rig even more versatile . . . gives you the plus value of a go-anywhere off-track switcher for hauling and spotting cars on your sidings, yard, or pit.

also spots and switches freight cars

car switching is required! Highly maneuverable in close quarters, unit turns around in its own length.

Off-track travel cuts switching time

SwitchTractor gives you several important advantages. Rolling on big, low-pressure rubber tires, this go-anywhere rig always takes the shortest route to every switching or hauling assignment. No matter where it happens to be working, unit easily highballs across yards, fields, tracks, ties, ditches, embankments to its next assignment — without damage to machine or roadbed. In hauling cars, it straddles tracks . . . does not chamfer ties or damage switches.

Depending on the distance and number of cars to be spotted or hauled, SwitchTractor can either push (with its dozer or push-plate), or pull with its drawbar. Coupling to cars with drawbar at rear takes but a moment. Coupler is safe, sturdy, standard RR type.

60% vs 30% coefficient of friction

Rolling on big rubber tires over ballast and ties, instead of with steel wheels on steel rails, SwitchTractor develops much more coefficient of friction (60% compared to 30%) than track locomotives of *twice* its weight. That means you have plenty of tractive power for fast starts and stiff rail grades in hauling cars. When not needed for handling cars on your pit or yard tracks, SwitchTractor keeps working productively for you as a dozer or towing tractor.

Worthwhile savings with SwitchTractor

If you have freight cars to move on your siding, yard, or pit, the added versatility of this new SwitchTractor will really pay off for you. Get all the facts on how this coupling-equipped go-anywhere tractor can save thousands of dollars for you in equipment investments and manpower economies. Phone or write us for details and a demonstration in handling *your* type of work.

SwitchTractor—Trademark, Tournatractor—Trademark Reg. U.S. Pat. Off. ST-1075-M

LeTourneau-WESTINGHOUSE Company

Peoria, Illinois

A Subsidiary of Westinghouse Air Brake Company

LeT W


take a good
look at these
TSP
products for the
mining industry
There are thousands of "Tool Steel Process" products in hundreds of applications in the Mining Industry. They're guaranteed to deliver longer life in the same service than any other competitive product.
Here's Why: TSP products are hardened by our special process. The file hard surface to the full depth of permissible wear gives maximum wear. The core, refined for toughness and ductility gives maximum strength.
Enjoy the tremendous savings in operating and maintenance costs you receive from guaranteed "Tool Steel Process" products.
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CAB ROLLERS
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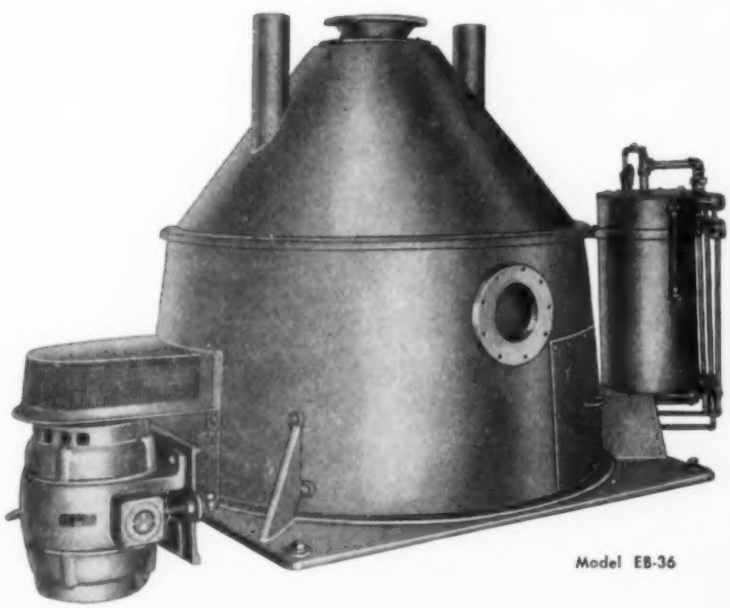
C·M·I

CONTINUOUS CENTRIFUGAL



Model EB-36

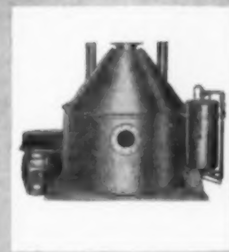
Economy and efficiency are combined to make C·M·I Centrifugal Dryers leaders in their field. The unprecedented basket design of this dryer provides greater capacity together with economy of operation. The coal is dried to a 6% surface moisture content without the use of expensive heat-drying operations. Increased resistance to shock loads is provided by the new V-belt direct drive, while clogging, and resulting clean-out jobs, are nearly eliminated by an enlarged and improved discharge channel.

The new C·M·I dryer provides savings in daily operation expense in addition to low installation costs. For only a few cents a ton, this dryer will actually earn extra profits for you through the reclamation of marketable coal from slurry ponds. C·M·I welcomes the opportunity to assist you with your particular problems in this field.

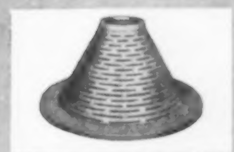
CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.

146 PRESIDENT STREET **SAINT LOUIS 18, MISSOURI**

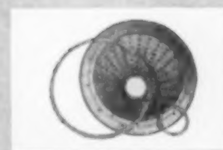
C·M·I Centrifugal DRYERS



Model EB-36 is compact, requires little space, little headroom.



The heart of Model EB-36 is the revolving basket and inner cone.



Metal clamping rings make it possible to replace worn out screens merely by loosening a few bolts — an exclusive feature.

Production capacity assures prompt delivery of new equipment and replacement parts at all times.

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CONTRACT DIAMOND DRILLING ANYWHERE

Many, many firms throughout the United States and the world know the advantages of core drilling; and Sprague & Henwood, with more than 70 years of experience, is the leader in this field. Sprague & Henwood crews have completed thousands of contracts successfully in every conceivable condition. For the best in exploratory core drilling (surface or underground), blast hole drilling, directional drilling, foundation test drilling, grout hole drilling, and pressure grouting—be sure to call Sprague & Henwood. Estimates and suggestions given without charge.

"ORIENTED" DIAMOND CORING BIT

IMPREGNATED CORING BIT

"ORIENTED" DIAMOND "TAPER" TYPE NON-CORING BIT

DOUBLE-TUBE REAMING SHELL

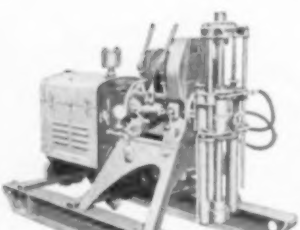
"ORIENTED" DIAMOND BITS

Any bit you buy will work for a while. But if you specify or order Sprague & Henwood "Oriented" Diamond Bits, giving all information on your drilling conditions, you will receive the bit or bits that will do the best job for you. Lower your cost per foot, with a minimum of diamond loss. Write today for complete "Oriented" Diamond Bit Bulletin #320-1.

RESETTING SERVICE

Send in your bits that need resetting, giving full details of results obtained and conditions under which bits were used. They will be returned new—and "Oriented" to give you less diamond loss and lower your cost per foot.

FIELD TESTED DRILLING MACHINES

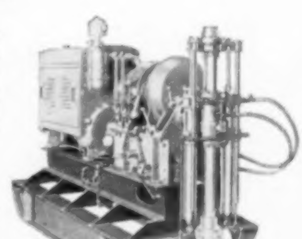


MODEL 40-C CORE DRILL MACHINE

Field Tested means just that . . . with contract work being done under every conceivable condition, Sprague & Henwood drilling machines have to perform right. Different sizes and types to meet various conditions are available. Your conditions should be given in detail, and recommendations will be forwarded to you immediately, without cost.

ACCESSORY EQUIPMENT

In addition to drilling machines, and diamond bits, Sprague & Henwood manufactures and can supply you with a complete line of accessory equipment necessary to make up a drilling outfit, such as drill rods, core barrels, casings, fishing tools, etc. A new and most complete Catalog, No. 400, listing all accessory equipment is available to you. Write today for your free copy. It will be mailed promptly.



MODEL 142 CORE DRILL MACHINE

SPRAGUE & HENWOOD, Inc.

SCRANTON 2, PA.

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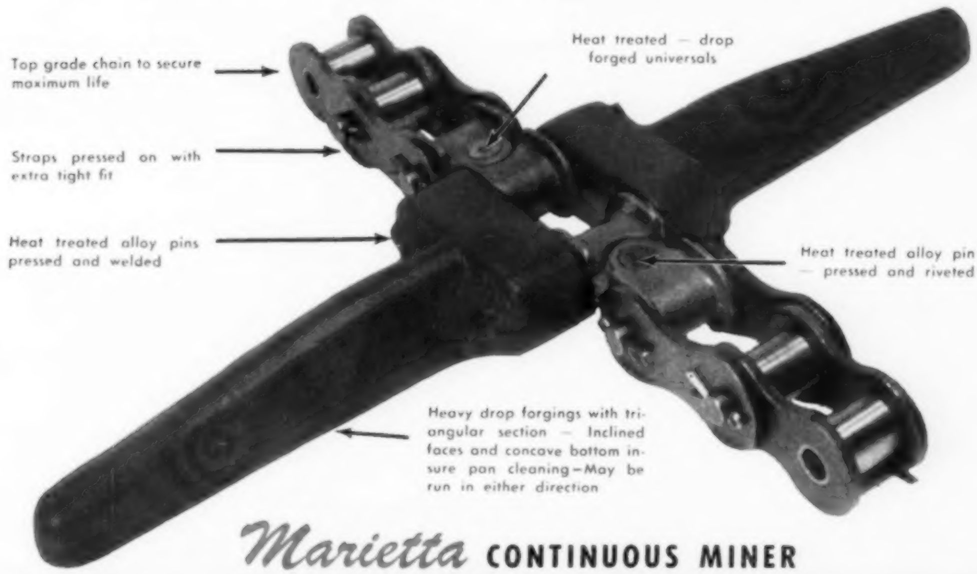
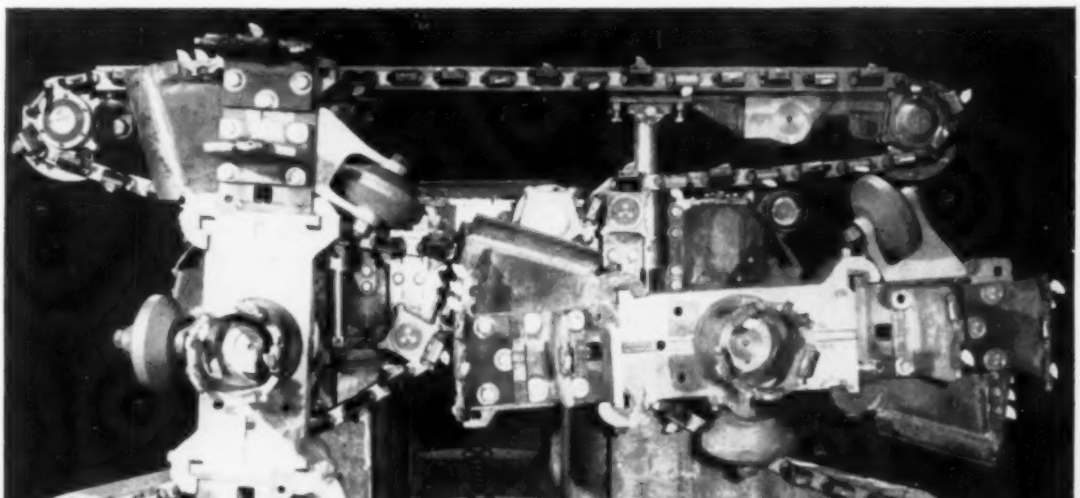
HEVI-DUTI UNIFLIGHT CONVEYOR CHAIN

FOR MOST LOADING MACHINES AND CONTINUOUS MINERS



Marietta CONTINUOUS MINER



CLARKSON MFG. CO. *"Redbird" - "Marietta"* **NASHVILLE, ILLINOIS**

HAVE YOUR COAL TEST-CLEANED in the modern R&S Pilot Plant

THIS modern R&S pilot preparation plant lets you take the guess-work out of coal cleaning. Using a full carload sample, with full size equipment, under actual operating conditions, it shows exactly what R&S equipment can do for your coal. At the end of the process all end products are analyzed by an outside, unbiased laboratory—Commercial Testing and Engineering Co. You get their full report in writing, plus the recommendations of R&S coal preparation specialists.

Write for your free copy of the new Pilot Plant Bulletin that tells the full story.

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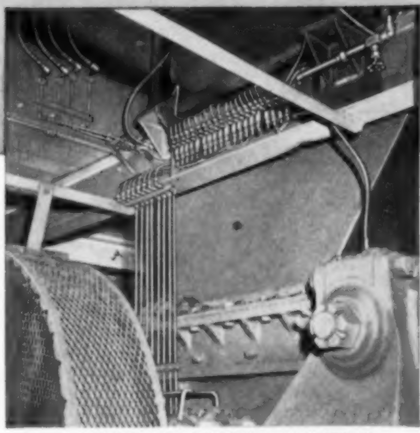
Get positive lubrication... slash mine operating costs with *Lincoln*



CENTRALIZED LUBRICATION SYSTEMS
(For One or Banks of Machines)
Lincoln Centralized Lubrication Systems are saving from $75,000 a year on a single power shovel to hundreds of thousands of dollars in processing plants.

LUBRICATION SYSTEMS

Whatever your lubricant application requirements may be—an automatic system for above or below ground equipment . . . automatic processing lines . . . positive maintenance of transport equipment . . . Lincoln has the tested cost-cutting solutions.

Lincoln has the most complete line of modern devices and systems on the market, backed by 35 years of engineering experience devoted exclusively to the design and manufacture of lubrication equipment. You can take advantage of Lincoln sales and service facilities anywhere . . . through our coast-to-coast network of leading industrial distributors and 16 Sales and Service Offices.

POWER-OPERATED DRUM PUMPS
(For Original 100 lb. or 400 lb. Drums)
Complete selection of Air-Motors and Pump Tubes.

GREASE GUNS (Heavy Duty Steel Construction)
Lube Capacities from 16 oz. to 32 oz.

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(All Types and Thread Sizes)
From Hydraulic Ball-In-Head to Self-Tapping.

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Lube Capacities from 30 lbs. to 60 lbs.

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(For Grease, Oil, Air and Water Services)
Heavy Duty, spring actuated.

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High and Low Pressure Models.

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(For Transferring Lubricants and Fluids From Original Drums)
Empties 55 gal. drum of S.A.E. 30 oil in two minutes.

PORTABLE LUBRICATION DEPARTMENTS
(For Heavy Construction Contractors)
Complete Combinations of Pumps and Hose Reels. Standard Groups or Custom-Built Rigs.

MATERIALS DISPENSING SYSTEMS
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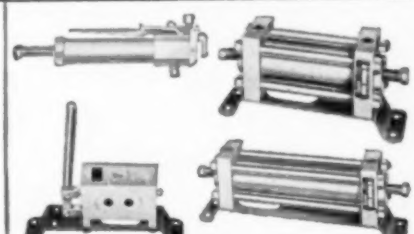
Complete Systems for Original 400 lb. Drums, or 5 gal. Packages.



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(Foot or Hand Actuated—Any Capacity)
For Injecting Metered Quantities of Lubricant on Assembly Lines.

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Meet every Coal Mining Power Drive Need

whether direct, indirect or dual drives

CENTRIC *"Trig-O-Matic"* OVERLOAD RELEASE CLUTCH

for positive—instantaneous—overload protection

Provides positive torque limitation without internal wear on the clutch. Trigger action disconnects the load the instant an overload occurs. After correction of overload condition, clutch can be reset in a few seconds without special tools. The driven machine then resumes operation at the exact cycle point at which it was released.

Centric "Trig-O-Matics" are available as pre-engineered, self contained units for every type of power drive.

For complete Centric "Trig-O-Matic" Clutch information and engineering data, send for Bulletin 304.

TYPE CFC
flexible coupling
for direct drive

TYPE S-
for sprocket,
sheave or gear
drive's attachment

TYPE SM
with sprocket
mounted integrally
on the clutch.

CENTRIC TYPE AVL HEAVY INDUSTRIAL, VERTICAL LIFT-OUT, SPRING CONTROLLED CLUTCH-COUPLINGS

for smooth starting and controlled acceleration on engine, turbine and dual drives

Full range of capacities 5 to 1500 H. P.

Provide full independent operation of either driver—to permit vertical lifting of driver or driven equipment from the mounting without telescoping. This is important in moving heavy equipment when telescoping is difficult or impossible.

Type AVL simplifies maintenance and shortens shut-down time.

SIMPLIFIED DISASSEMBLY—Just remove the screws on the CENTRIC—slide the inner drive member over the hubs—lift vertically out. That's all.

Bulletin 302 gives complete details and engineering data.

430

CENTRIC *Clutch Company*

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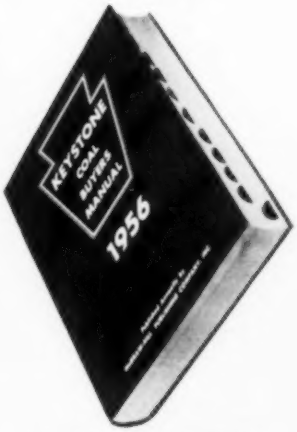
Recommended for Buyers and Sellers of Coal



1956 KEYSTONE COAL BUYERS MANUAL

AUTHENTIC, UP-TO-DATE DATA ON

Coal Sales Organizations
Characteristics of Seams
Coal Operating Companies
Trade Names
Cleaning Plants
Coal Mines

DETAILED MINE DATA INCLUDES:
Location, by town, county, state, railroad. Kind of opening seam and thickness. CLEANING, DRYING AND PREPARATION EQUIPMENT, SIZES SHIPPED. DAILY CAPACITY, ANNUAL PRODUCTION, LIFE EXPECTANCY. INDICES BY MINES, COMPANIES, SALES EXECUTIVES, SALES OFFICES, OPERATION EXECUTIVES.

Each Annual Edition includes 33 1/3% Change in Detail Listings on Companies and Mines.

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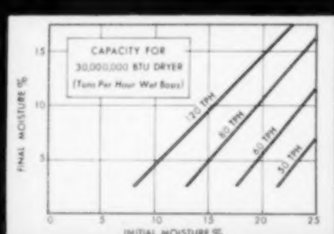
DRY FOR LESS MONEY

The **PARRY DRYER** has proved its ability on difficult applications of both bituminous coal and lignite. It dries any ½ x 0 mesh coal with remarkable economy . . . combines perfect safety and precise control with compact and simple construction. Provides immediate response to feed or demand, suitable for a wide variety of working capacities.

Compare **the Parry Turbulent Entrainment Dryer on every count. Literature and operating data on request.**



Graph **illustrates throughput capacity of a typical Parry Dryer for various moisture contents in the feed and product.**

SILVER ENGINEERING WORKS, INC.

3313 BLAKE STREET • DENVER 5, COLORADO

FOR USE ON ALL TYPES OF MACHINES

Each mining operator has his preference for certain mining machines, but regardless of the type of machine or the cutting problem, CINCINNATI has the chains, bits and bars that will give you top efficiency. CINCINNATI has specialized in the design, manufacture and perfection of Coal Cutting Equipment for more than a quarter century. In addition, CINCINNATI is headed by men who have devoted their lives to improved coal cutting equipment . . . to keeping ahead of the field at all times. Today, CINCINNATI MINE is not only manufacturing chains that out-perform and outlast any other chains available for every type of CONTINUOUS MINING MACHINE now on the market, but have developed NEW CHAINS especially adapted for SPECIAL CONTINUOUS MINING MACHINES not yet generally known to the field. Our constant endeavor is to provide the industry with the most improved equipment at all times. Our representatives and our engineering staff are always at your service.

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- Storage and Handling
- Supply Houses
- Supply Delivery
- Waste Prevention

For manufacturers of equipment, materials and supplies used in supply handling, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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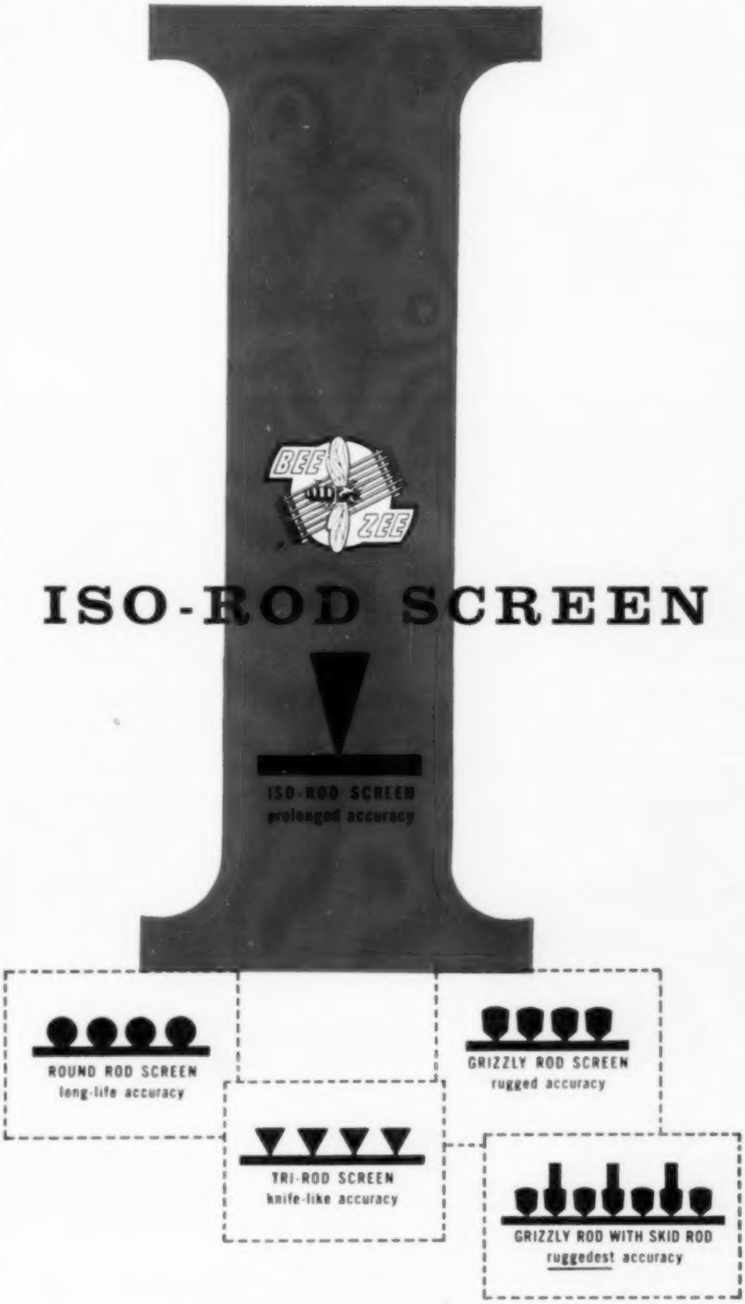
COAL AGE'S MINING GUIDEBOOK and BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers



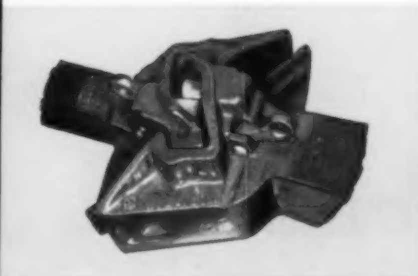
Iso-Rod Screen is new...and it's covered in the new BIXBY-ZIMMER SCREEN BOOK just off the press. Write, or phone for your free copy. And remember—Bee-Zee Screens make you money by giving your coal more btu's per ton... because more of that ton is coal... less of it water.

Better find out about these screens that are 100% stainless steel... electronically precision-welded... won't rust or corrode...can be fitted to any equipment.

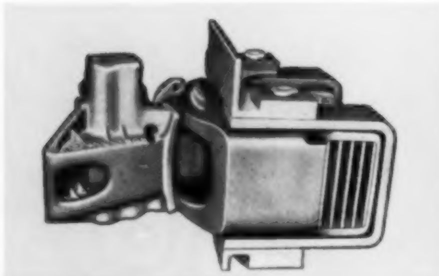
BIXBY-ZIMMER
ENGINEERING COMPANY
196 Abingdon Street, Galesburg, Illinois

NATIONAL equipment cuts per-ton costs

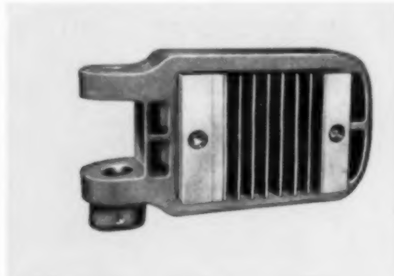
NC-1 MINE CAR TRUCK is the latest example of National's pioneering in better equipment. Among NC-1 truck advantages are longer and softer ride springs, friction damping mechanism that controls vertical and transverse oscillations, automatic frame alignment and cast one-piece bolster with large lubricated center bearing. AA-2240



WILLISON AUTOMATIC COUPLERS save time with maximum safety, couple at either end of car or locomotive, require no manual assistance, eliminate damaging slack, permit high speeds with maximum stability.



NATIONAL MI-235 Rubber-Cushioned Draft Gear primarily used in Willison spherical-horn coupler assemblies for drop-bottom cars and locomotives; are effective with link and pin bumpers and in strap yokes.



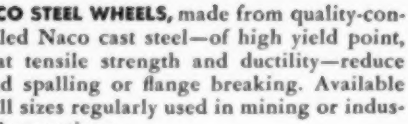
NATIONAL MI-225 Rubber-Cushioned Draft Gear for locomotives and large capacity cars not required to operate through rotary dump. Give maximum impact protection in minimum space.

NATIONAL MI-230 Rubber-Cushioned Draft Gear for cars in rotary dump service. High-capacity rubber pads with soft initial action provide maximum impact protection, lengthen equipment life. Available in capacities and designs to fit individual requirements.

NACO STEEL WHEELS, made from quality-controlled Naco cast steel—of high yield point, great tensile strength and ductility—reduce tread spalling or flange breaking. Available in all sizes regularly used in mining or industrial operations.

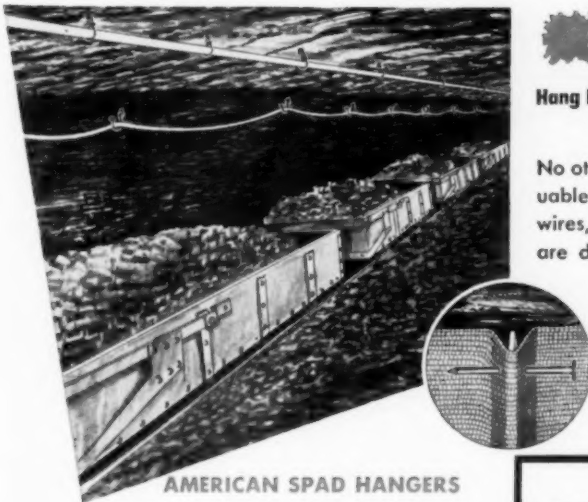
Over 100,000 Willison Automatic Couplers have been installed in cars and locomotives engaged in mining operations, industrial plant hauling and foreign railway service.

Technical Center



"Progress through Research"

NATIONAL
MALLEABLE AND STEEL
CASTINGS **COMPANY** • Cleveland 6, Ohio



SOLVE YOUR HANGING PROBLEMS

Hang Brattice Cloth • Water Pipe • Air Hose • Telephone Lines

FASTER . . . EASIER . . . WITH AMERICAN SPADS

No other method offers such streamlined production plus such valuable time savings for erecting brattice cloth, supporting electric wires, water pipes, telephone and air hose lines. American Spads are driven directly into the coal—thus eliminating all need for lumber—and cutting labor costs.

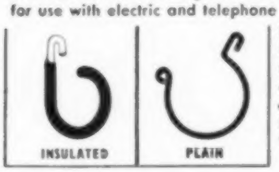
You can depend on American Mine Supply equipment for efficient and economical performance. It is backed by many years of scientific research and experimentation.

Enlarged view showing spad used to obtain an airtight seal in fastening brattice cloth for temporary stoppings, cross curtains, line brattice, etc.

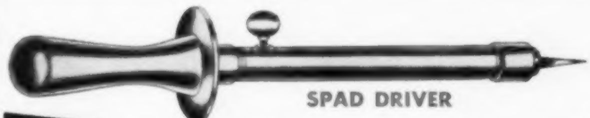
AMERICAN SPAD HANGERS

are economical and time-saving—suitable for either side wall or roof suspensions. Just drive a Spad—clip on a hanger—and you have a quick, sturdy installation for pipe, hose or cable. Extra high tensile strength—ample for the most demanding installations.

The new insulated hangers have been especially developed for use with electric and telephone lines.



Specify American Spad Hangers, Plain or Insulated, for Quality and Economy. Plain—available in two styles: Lock Type and Open Type.



SPAD DRIVER

SPADS

The SPAD DRIVER is a precision instrument specifically designed for use with American Spads. Investigate the proven performance—add up the advantages and the many savings—of this modern method.

AMERICAN MINE SUPPLY COMPANY

404 FRICK BUILDING PITTSBURGH 19, PENNA.

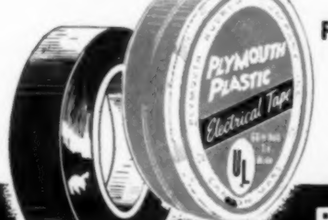
Additional Literature Upon Request

SLIPKNOT . . . SYMBOL of SAFETY in the Mining Industry

SLIPKNOT FRICTION TAPE LEADS ALL OTHERS IN PREFERENCE

Consistent high quality . . . far in excess of all specifications . . . has made Slipknot the most widely used friction tape in the mining field.

This outstanding Friction Tape is guaranteed not to dry out. It will not ravel at the edges and retains its exceptional adhesive qualities under all conditions.



PLYMOUTH PLASTIC ELECTRICAL TAPE

Another Top Performer, Plymouth Plastic Electrical Tape is thinner — for neater, more compact jobs. Has high dielectric strength, resists water, oil and corrosion.

PLYMOUTH RUBBER COMPANY, INC.

Established in 1896

CANTON, MASS.

THE C-E RAYMOND *Flash Drying* SYSTEM

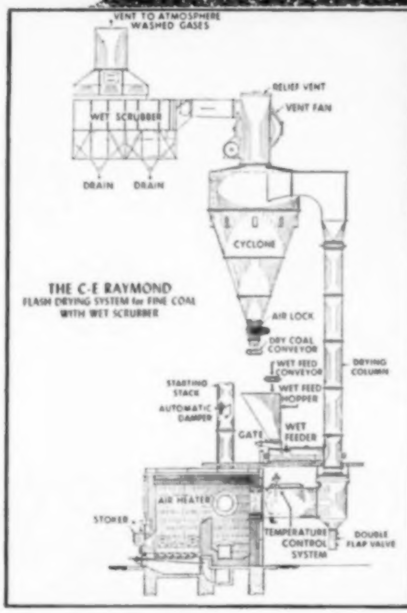
. . . A COMPLETE COORDINATED UNIT FOR THE RAPID DRYING OF FINE COAL

This modern coal drying equipment is carefully engineered to each specific job so as to provide any desired capacity requirements for the production of fine coal from 3⁄8″ or below in particle size.

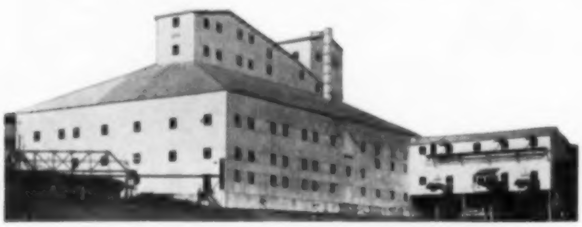
It combines important new developments and operating features that assure utmost economy in the process and uniformity of product.

The fast drying action and the new type coal trap help to solve the coal degradation problem even in the softer coals. The addition of a special wet scrubber device to the vent system controls air pollution around the plant to meet smoke ordinance restrictions.

Smooth, clean, automatic operation, ease of installation with low power consumption and minimum maintenance costs, are some of the reasons for the widely increasing use of C-E Raymond Flash Drying Systems in coal preparation plants.



For further details, write for our bulletin of C-E Raymond Flash Drying Systems for Fine Coal.



One of the larger installations at a Western Pennsylvania plant—175 Tons per hour of 1⁄4″ x 0 coal, dried from 8% to 2% moisture, with multiple drying column.

Typical of smaller plants — Alva, Kentucky — Two grades produced: 45 tons per hour of 1⁄4″ x 28-mesh; and 15 tons per hour of 28-mesh coal with final moisture content of 2%.

C-E Raymond Flash Drying Systems built to serve large and small coal preparation plants—with single drying column for handling 10 to 80 tons per hour. Multiple columns connected to one furnace for higher capacities.

COMBUSTION ENGINEERING, INC.

Raymond Division

1315 NORTH BRANCH ST., CHICAGO 22, ILLINOIS

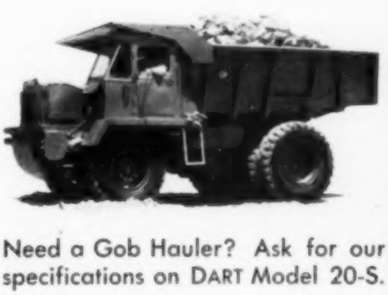
SALES OFFICES IN PRINCIPAL CITIES

Combustion Engineering-Superheater Ltd., Montreal, Canada

Dart's popular 50-S-BDT coal hauler carries 60 cubic yards — 50 tons. It is available with 300 or 335 HP diesel engine, Allison converter and 3-speed transmission, or optional Twin Disc converter and 4-speed transmission.

Quality Built...

for lower tonnage cost



Need a Gob Hauler? Ask for our specifications on DART Model 20-S.

DART'S leadership in coal haulage is a result of quality engineering and construction . . . which in turn assure high tonnage performance at reduced costs.

The large fleets of DART coal haulers operating in many of the largest strip mines have produced outstanding performance records for tonnage versus costs.

There is a DART man near you.

DART TRUCKS
TONNAGE ENGINEERED
Kansas City 8, Missouri
SUBSIDIARY OF THE CARLISLE CORPORATION

Can You Use Another Copy of This Guidebook at Your Home or Office?

We have a limited supply of this 1956 MINING GUIDEBOOK available at 50¢ each for COAL AGE subscribers desiring an extra copy. Write: The Editor, COAL AGE, 330 West 42nd St., New York 36, N. Y. Please enclose check or money order.

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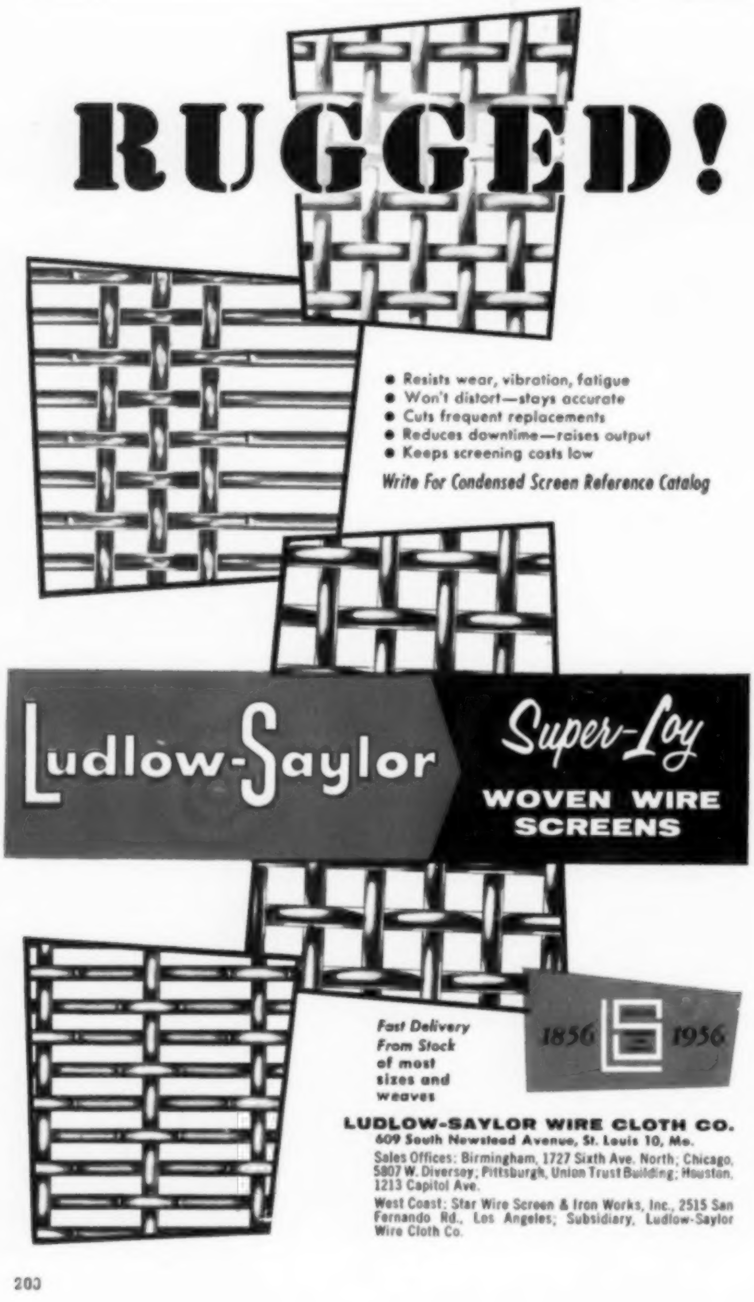

TROUBLED?

Your rerailing problems are minimized with the Universal Car Replacers.

ANY 2 MAKE A PAIR

Locks to rail

Available in all sizes

RAIL BENDERS

Hydraulic—Jack—Screw Types

Write for Literature

THE ALDON COMPANY

3338 Ravenswood, Chicago, Ill.

Here's the Most Complete BUYING DIRECTORY You Can Find!

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1956 edition.

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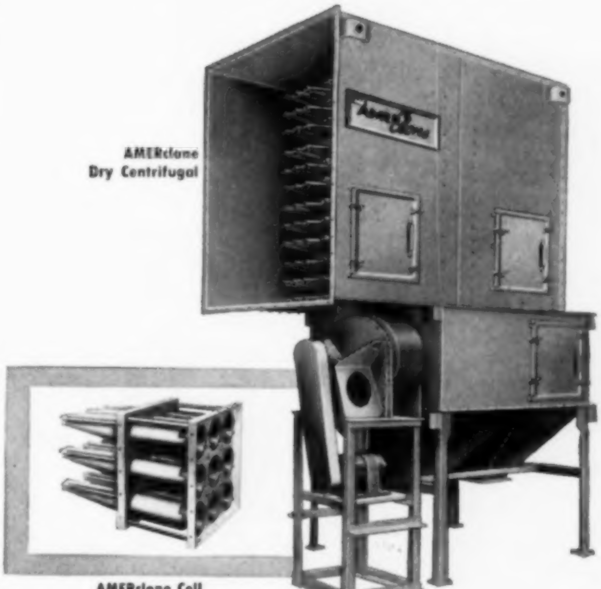
DOUBLE TROUBLE FOR COAL DUST

Type N ROTO-CLONE
Hydro-Static
Precipitator



AMERclone
Dry Centrifugal

AMERclone Cell

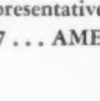
Two AAF collectors prove versatility in all coal processing operations

LOWER cleaning costs, better employee relations, elimination of explosion hazards, an end to atmospheric pollution—these are benefits that progressive coal operators are getting with AAF dust control equipment. Wherever there's dust in coal cleaning and processing—crushers, bunkers, conveyor transfer points, screens, dryers—there's a place for either AAF's wet-collecting Type N ROTO-CLONE or the AMERclone dry centrifugal.

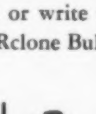
In most tipple operations, the Type N ROTO-CLONE does the job . . . effectively and inexpensively. The high cleaning efficiency of this hydrostatic precipitator is the result of the combined action of centrifugal force and the thorough intermixing of water and dust-laden air.

Wherever reclamation of dust is desired (such as drying operations), AAF's AMERclone is assigned the primary collection job. The space-saving AMERclone features 3,000 cfm cleaning capacity in each 20" x 20" cell. And AMERclone *maintains* its high efficiency over a wide range of air volumes.

Clean coal plant operation is a cinch when dust is double-teamed by AAF's AMERclone and Type N ROTO-CLONE. For complete information, call your local AAF representative or write direct for Type N Bulletin 277 . . . AMERclone Bulletin 291.



AAF Filters and Precipitators



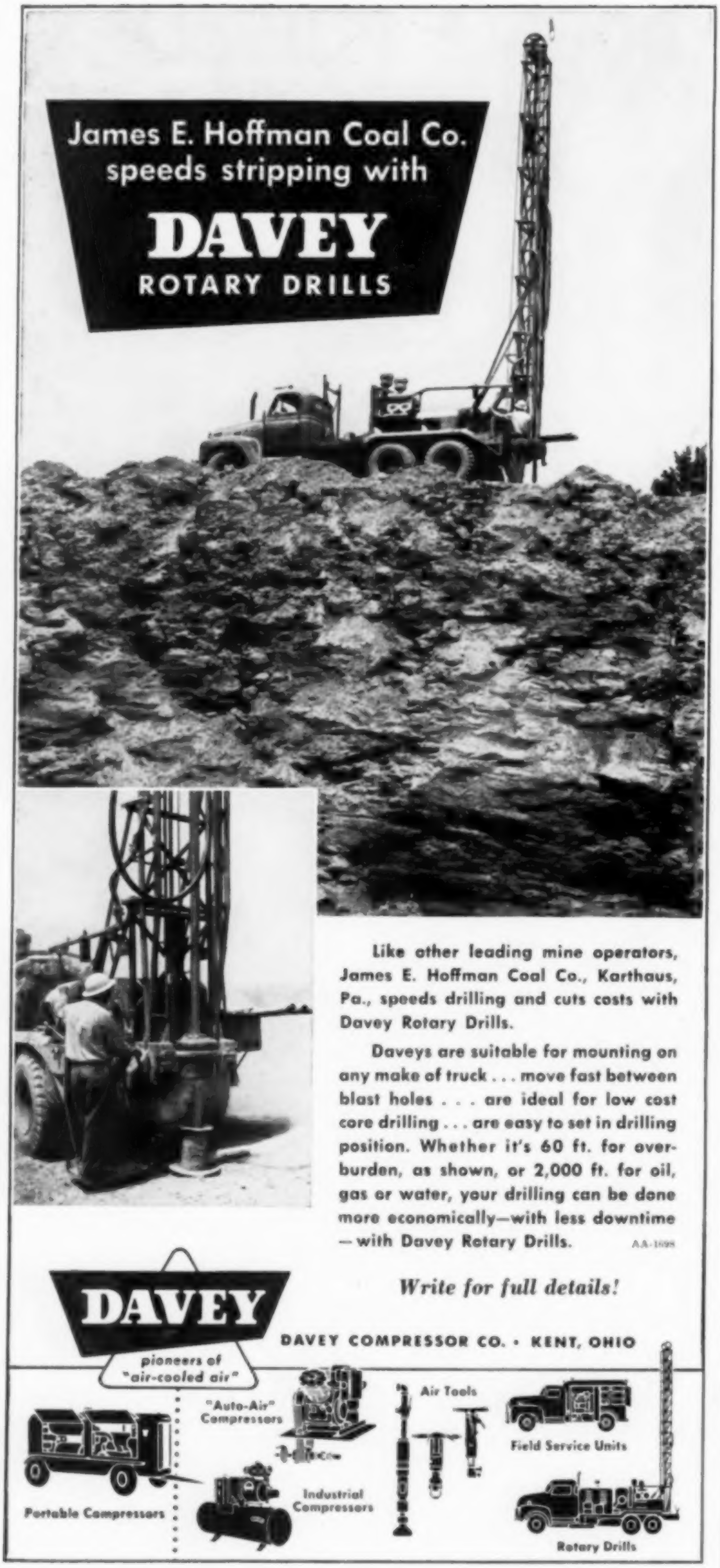
Illinois Heating Specialties

American Air Filter
COMPANY, INC.
215 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

—— BETTER AIR IS OUR BUSINESS ——

Herman Nelson Unit Heaters

AAF Dust Control Equipment



Are You Seeking New Ideas On MAINTENANCE?

Be sure to check through pages 118-129 of this Guidebook for the latest developments in:

- Organization
- Reports
- Standardization
- Personnel Training
- Spare Equipment
- Lubrication
- Mobile Units
- Shops
- Scheduling

For manufacturers of equipment, materials and supplies used in maintenance, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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An established annual service for all COAL AGE subscribers

CUT MAINTENANCE WITH

RUBEROID

INSULATING TAPE • ROOFING • SIDING • PARTITIONING

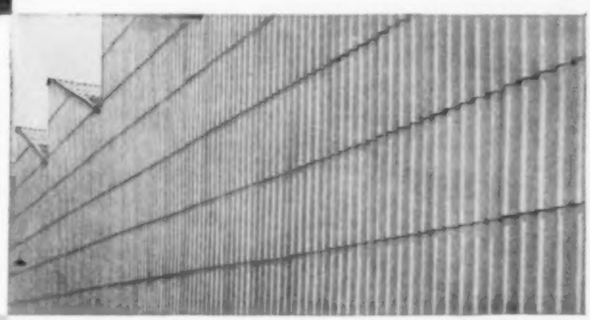
Durable materials resist corrosion, abrasion in coal mine use—
Reduce upkeep and replacements costs

RUBEROID INSULATING TAPE

Made of tough fabric saturated with asphalt, Ruberoid Insulating Tape is adhesive on both sides . . . provides the strongest possible grip that won't tear or ravel. Ruberoid Insulating Tape exceeds A.S.T.M. specifications by 40% in adhesiveness . . . 25% in tensile strength . . . 110% in dielectric strength.

LOW COST STONEWALL ASBESTOS BOARD

Fireproof, rotproof Stonewall Board is the ideal building material for indoor partitioning. Easy to apply yet long on wear. Durable Stonewall is ideal for wall surfaces where excessive dampness and corrosion shorten the life of other materials. Stonewall never needs paint, requires virtually no upkeep.



LOW MAINTENANCE CORRUGATED ASBESTOS SHEETS

Light in weight, strong in performance, Ruberoid corrugated asbestos sheets are fire-proof, weather-proof, non-corrosive. Ideal for installations exposed to acid, fumes, smoke or steam. Ruberoid corrugated sheets never need paint and are attractive and practical for both interior partitions and exterior siding.

RUBEROID BUILT-UP ROOFING

For years of low maintenance roofing, insist on Ruberoid's 3-way protection: (1) Exact specifications to meet any need from the complete Ruberoid Built Up Roofing Specification Book. (2) Complete line of quality materials . . . such as Roofing Pitch and time-tested Ruberoid Special Bitumen, to meet every need. (3) Expert application by a Ruberoid Approved Roofer to assure experienced workmanship and familiarity with all types of roofing problems.

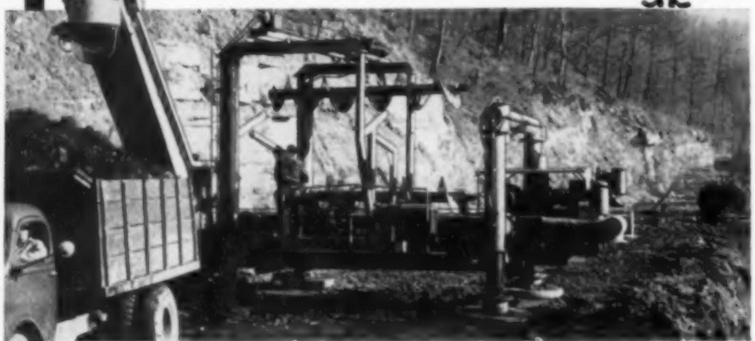
The RUBEROID Co.

ASPHALT AND ASBESTOS BUILDING MATERIALS

500 Fifth Ave., New York 36, N. Y.

SMALL IN SIZE . . .

BIG *in performance . . .*



Compton Budget Model 28 Coal Auger

The latest of the famous, efficient Compton Coal Augers, but already known for its record setting performance figures. Only 28 feet long this Compton Auger, with a crew of just 3 men will auger and load up to 65 tons of coal per hour. Compact and lightweight, it is right at home even in cramped quarters and does not require a great deal of costly advance preparation.

GENERAL SPECIFICATIONS—MODEL 28

Length: 28 feet
Weight: Approx. 25 tons
Carries twelve 12½ ft. auger sections
Required pit width: 30 ft. min.
Power: 175 hp Diesel engine
Hydraulic Frame Jack Lift: 54 inch
Auger Diameter: 44″ to 28″
Drills coal within 4¾″ of the bottom
Max. Drilling Depth: 150 feet

Only Compton Augers are equipped with the job-proven, non-clogging Compton Lump Recovery Head. Their built-in spider bearing assembly assures straighter drilling with less frictional drag.

Compton, Inc.

ORIGINATORS OF COMPTON LUMP RECOVERY HEADS

BOX 1946 • TELEPHONE 4-6384
CLARKSBURG, WEST VIRGINIA

Are You Seeking New Ideas On PREPARATION?

Be sure to check through pages 98-117 of this Guidebook for the latest developments in:

- Raw-Coal Handling
- Crushing
- Sizing
- Washing
- Air Cleaning
- Dewatering and Drying
- Mixing and Blending
- Dustproofing
- Loading
- Sludge Recovery
- Refuse Disposal

For manufacturers of equipment, materials and supplies used in coal preparation, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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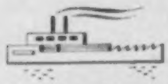
Kleenslot
WEDGE WIRE PREPARATION SCREENS


mining


foods


chemicals

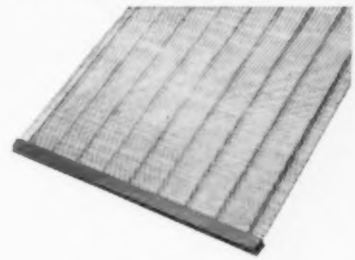

abrasives


oil

FOR DEWATERING, SCREENING, WASHING, EXTRACTING, FILTERING or SIZING APPLICATIONS

SCREEN GUARDS

A new innovation in the mining and industrial field. Particularly adaptable for use in flumes. The screen guard is built right into the screen and the vertical guard bars keep the larger lumps of material above the guard bars, permitting only the finer particles to pass over the screen. Special sizes can be furnished.



VIBRATOR SCREENS

They can be designed and adapted to fit any make of vibrator. You do not have to change your present machine to accommodate this screen. It is of quality construction and built to give maximum service. The rigid construction and method of installation prevents "whipping".

MARCEL-TYPE SCREENS

This screen is entirely different inasmuch as it is of a Marcel-type construction. It was designed for operations where slivers passing through are objectionable in the end product. This screen can be made in all sizes and shapes wherever applicable to higher and productive efficiencies. It gives long life and non-blinding operation.

ALUMINUM SCREENS

This aluminum screen has all of the attractive and sturdy features of many other metals. In addition, it offers flexing action that adds capacity and dewatering abilities which are almost unbelievable. No changes are necessary in the body of the screen to effect its installation.

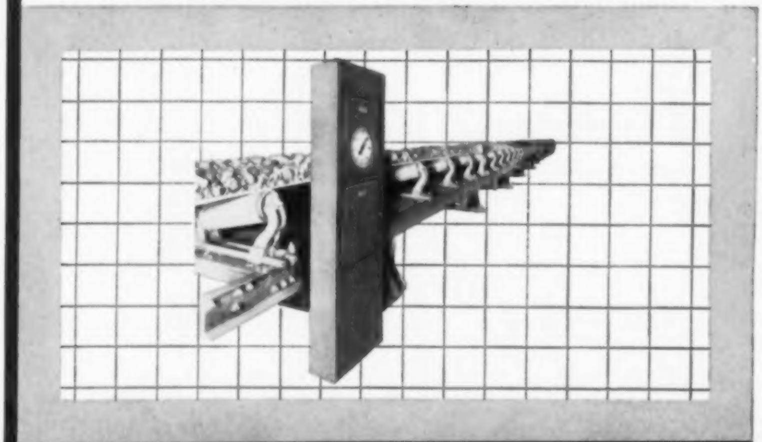
NON-BLINDING —NON-CLOGGING – LONGER LIFE – MOST ECONOMICAL

The diagram at left shows all of the efficiency that can be furnished to you by KLEENSLOT Wedge Wire Preparation Screens, inasmuch as the wedge construction permits easy clearing. KLEENSLOT Wedge Wire Screens can be furnished in practically any type of metal. It costs nothing to obtain a Wedge Wire recommendation free of charge. Complete literature is available for the mining, oil, food, chemical and abrasives industry. There is a KLEENSLOT Wedge Wire Screen for every application.

★

WEDGE-WIRE CORPORATION
GAS STREET AND NICKEL PLATE R. R.
WELLINGTON, OHIO

COSTS DOWN! PRODUCTION UP!



. . . WITH BUILDERS *Conveyoflo*

CONVEYOFLO® Meter is a precision unit of rugged construction for accurate totalization of all belt-conveyed materials. With the addition of a controller, a preset rate of delivery will be maintained. With the addition of a pneumatic transmitter, it can pace proportionally the delivery from auxiliary feeders in automatic processing systems. Conveyoflo comes as a complete unit including conveyor, drive, and weighing mechanism . . . or can be installed in your present conveyor lines. Here is thoroughly reliable, service-proven equipment.

FEATURES

- ACCURACY — within plus or minus 0.4 of 1% of full scale load over a 10:1 range.
- CONTINUOUS INTEGRATION — automatically compensates for variations in belt speed . . . provides accurate response to rapid load variations.
- OVERLOAD PROTECTION — weighing element and calibration not subject to damage by overloading.
- PNEUMATIC OPERATION — inherently explosion-proof.
- COMPACT — weight sensing mechanism completely contained within conveyor structure. Panel located above or below conveyor as desired.

ACT TODAY!

Bulletin 550-H4A gives complete data on Conveyoflo operation, accuracy, totalizer head, weigh spans, etc. Request your copy from **Builders-Providence, Inc., 395 Harris Ave., Providence, R. I.** . . . division of

B-I-F INDUSTRIES
PROVIDENCE, RHODE ISLAND
METERS FEEDERS CONTROLS

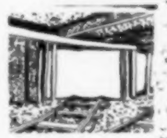
BUILDERS-PROVIDENCE, INC. • PROPORTIONEERS, INC. • OMEGA MACHINE CO.

THE OUTSTANDING MINE VENTILATION LINE

Outstanding

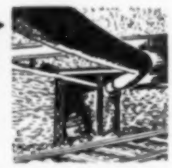
✓ FOR QUALITY
✓ FOR DEPENDABILITY
✓ FOR COMPLETENESS

ABC BRATTICE CLOTH



7 types to fit all needs—3 types of jute cloth, 2 types of cotton, plastic and Black Ace for nongaseous mines. Carefully processed to resist flame, except Black Ace, and to resist mildew. In widths and lengths for any seam.

MineVent



FLEXIBLE VENTILATION TUBING

Made in two grades: jute base and cotton base, synthetic rubber coated. Resists leakage, abrasion and moisture. Available in 9 diameters, 8" to 36" and 25, 50 or 100 ft. lengths. Choice of 3 types of suspension, demountable patented Snap-On coupling or Sewed-In coupling. Most widely used mine ventilation tubing.

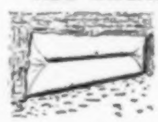
NEOLON FLEXIBLE VENTILATION TUBING

The new Neoprene coated Nylon fabric tubing. Almost impossible to tear. Airtight. Resistant to abrasion, acid mine water and flexing. Same lengths and diameters as MineVent.

NON-COLLAPSIBLE TUBING

Both MineVent and Neolon are available with telescoping spring wire inserts rendering the tubing non-collapsible. Light weight. Economical.

ABC INFLATABLE BRATTICE



Sizes to fit any opening. Readily fills rough contours, jagged walls, etc. Quickly inflated by special hand pump. Quickly deflated to move to new location. Easy to transport. Economical to use.

ABC POWDER BAGS

Rubber coated durable fabric, firmly sewed, for long use and hard wear. 5 sizes: 20, 30, 60, 125 and 160 sticks of explosive.

Send for Catalog 56.

A B C AMERICAN BRATTICE CLOTH CORP.
WARSAW, INDIANA
MAIN OFFICE: 200 S. Buffalo St.

12-ton ore bridge, built, designed and installed for a large steel company.

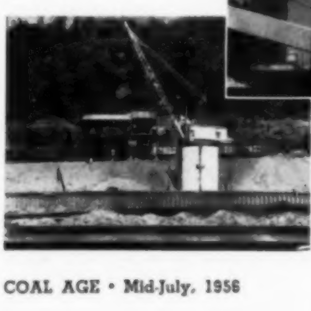
DRAVO **HEAVY MATERIALS-HANDLING** EQUIPMENT ...CUSTOM BUILT FOR **YOU!**

Travelling unloading towers built to handle imported iron ore at an Atlantic port.

Whirler crane mounted on pontoon hull is used for dredging and general contract work.

Light-weight man trolley installation increased bridge handling capacity 60%.

Coal unloader designed and built for a large mid-western electric power company.



Stationary whirler crane designed and built to transfer coal from barges to hopper cars.

Over-all economical and safe performance is best obtained by using materials-handling equipment designed to suit your operating conditions. If you're planning a new materials-handling installation, we suggest an early "Round Table" session with Dravo engineers.

From actual experience over the past 60 years in building and installing the equipment shown here, valuable data is available in working out the features you want in your installation. This information, along with your own operating experience, can be used to create a design incorporating all the best features for easy maintenance, a high safety factor and simple, economical and satisfactory operation.

You can profit by taking advantage of this specialized "Round Table" service.

DRAVO

C O R P O R A T I O N

NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA

AIR CONDITIONING • BOILER AND POWER PLANTS
CRANE CAB COOLERS • DOCKS • INDUSTRIAL FOUNDATIONS
OPEN STEEL FLOORING • PUMP HOUSES AND INTAKES
SPACE HEATERS • WATER AND WASTE TREATMENT PLANTS
TOWBOATS AND BARGES

The Last Word In Screening Efficiency

The word's out on wedge wire and Hendrick has it!

That's right. With the addition of new Hendrick Wedge Wire, Hendrick now makes available a complete line of screens for the best in efficient, low-cost screening, de-watering and filtering operations. It's ideal wherever it is important that screen openings be minutely fine, have excellent draining qualities and a high degree of accuracy and rigidity. For details on how Hendrick Wedge Wire can best be applied to your specific requirements to afford tops in low-cost, efficient screening call your nearby Hendrick Sales Engineer. He's listed in your local classified telephone directory under *Perforated Metals.*

HENDRICK
MANUFACTURING COMPANY
Dundaff Street, Carbondale, Pa.
Sales Offices in Principal Cities

Perforated Metal • Perforated Metal Screens • Wedge-Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer

Are You Seeking New Ideas On DEEP MINING?

Be sure to check through pages 18-75 of this Guidebook for the latest developments in:

- Opening and Developing
- Mining and Loading
- Face Preparation
- Roof Control
- Transportation
- Ventilation
- Pumping and Drainage
- Electric Power

For manufacturers of equipment, materials and supplies used in deep mining, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the industry.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Advertisers' Index at the end of this issue. You'll find more useful information in their advertisements.

When buying, or requesting product data, please mention

COAL AGE'S MINING GUIDEBOOK and BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers

Specify Pressure-Treated . . .

MINE TIES CRIBBING LAGGING TIMBER SETS TROLLEY POLES TRESTLES

YES, PRESSURE-TREATED WOOD saves money for mine operators, because it gives built-in protection against decay and termite attack. As a result, pressure-treated mine ties, timbers, trolley poles, trestles, etc., retain their strength, and last 4 to 5 times longer than untreated material. Money is saved because maintenance and replacement costs are greatly reduced and repair "down time" virtually eliminated.

Why does this treated wood retain its strength and last so long? Because in Koppers pressure-treating process, the wood is not merely dipped, soaked or brushed. Instead, Creosote or Wolman® salts are forced, under pressure, *deep into the wood,* giving thorough, lasting protection against decay and termite attack.

Be sure to specify pressure treatment wherever wood must serve under severe conditions. Koppers is ready to supply creosoted or Wolmanized-treated materials to meet your specifications. For additional information, or the name of your local Koppers representative, write to Koppers Company, Inc., Wood Preserving Division, Pittsburgh 19, Pennsylvania.

KOPPERS

KOPPERS

PRESSURE-TREATED WOOD

TOP REQUISITE ...RUGGEDNESS!

COLLYER Mining Cables are constructed to meet the severest punishment that constant abrasion, flexing, impact, and crushing can inflict during shuttle car operation. Extra ruggedness is built into the dense, lead-cured Neoprene sheath which protects the rubber insulated, flexible conductors. Send for a recommendation on your cable requirements . . . standard or special . . . and learn why more and more colliers specify Collyers.

Collyer

COLLYER INSULATED WIRE CO., 245 Roosevelt Avenue, Pawtucket, Rhode Island

Are You Seeking New Ideas On SAFETY?

Be sure to check through pages 140-144 of this Guidebook for the latest developments in:

- Safety Organization
- Training and Education
- Maintaining Mine
- Keeping Interest Up
- Deep and Strip Safety Methods

For manufacturers of equipment, materials and supplies used in safety, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Advertisers' Index at the end of this issue. You'll find more useful information in their advertisements.

When buying, or requesting product data, please mention

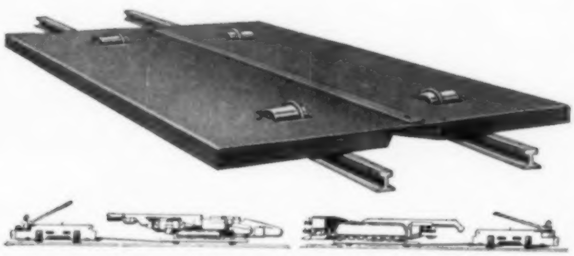
COAL AGE'S MINING GUIDEBOOK and BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers

Check these PHILLIPS LOW HEIGHT MINE EQUIPMENT CARRIERS

The New "PHIL-DOLLY"

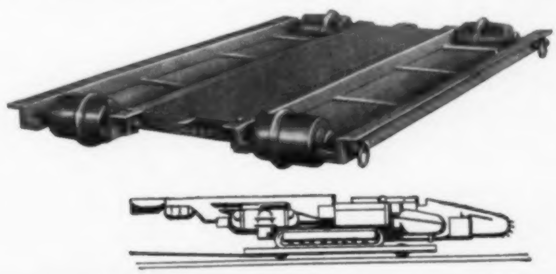
for hauling "continuous mining machines"



Featuring modern streamlined design, all welded heavy gauge steel construction, cast steel wheels, Timken roller bearings . . . the new "Phil-Dolly" is available in two types, Model PD, 20 ton capacity for Joy Continuous Mining Machines and Model PD-EG, 35 ton capacity for Jeffrey Colmol. Track gauge from 36" to 56½". Head room required—6⅛" for Model PD and 12" for Model PD-EG. Write for more information.

LOAD CARRIER Model LC

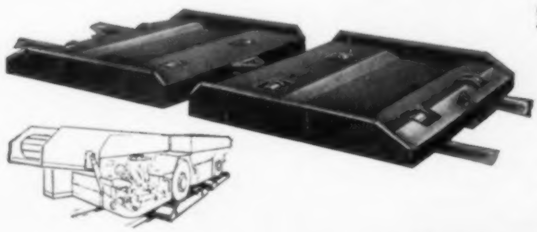
for hauling coal loaders, cutters, etc.



Built to carry heaviest loading machines to and from work areas, the Loader Carrier requires only 3¼" of head room. Built for any track gauge. Write for more information.

SHUTTLE CAR CARRIER
Model SC

hauls shuttle cars to and from work areas



Requiring only 4⅞" of head room, Shuttle Car Carriers are furnished in track gauge from 36" to 56½". Write for more information.

Phillips dependable mine equipment carriers are built to suit your requirements regardless of the type of machinery to be hauled to and from work areas. When requesting quotation, please send manufacturer's name and model number of equipment to be carried. Representative will call on request.

SALEM-BROSIUS, INC.
20 ARCH STREET · CARNEGIE, PA.

PHILLIPS MATERIALS-HANDLING EQUIPMENT

Manufacturers Since 1863

This BUYERS' GUIDE Is Right Up-to-the-Minute

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1956 edition.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Advertisers' Index at the end of this issue. You'll find more helpful product information in their advertisements.

COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers.

Serving the Coal Industry Since 1923

WARNER LABORATORIES

ANALYSIS

SAMPLING • WASHABILITY TESTS

"ON THE SPOT" COAL SAMPLING IN PENNSYLVANIA OHIO WEST VIRGINIA

Adequate Samples Insure Correct Analyses

These Representative Companies Have Used Our Facilities for Washability Tests.

Acosta Gray Company
Atlantic Crushed Coke Company
Cable Coal Company
Cambria Fuel Company
Clover Run Coal Company
Crichton Coal & Coke Company
Denise Coal Company
Dixonville Coal Company
Dunlo Coal Company
Dunwell Contractors
Ebensburg Coal Company
Elliot Coal Mining Company
Fetterolf Coal Company
W. O. Gulbranson
L. W. Hicks
C. A. Hughes & Company
Imperial Coal Corporation
Johnstown Coal & Coke Company
Marco Coal Company
Marshall Mining Company
Morrisdale Coal Mining Company
Neilan Engineers
Northwestern Mining & Exchange Company
Peale, Peacock & Kerr, Incorporated
Pennsylvania Coal & Coke Corporation
Pennsylvania Electric Company
Penn Fuel & Supply Company
Pine Township Coal Company
Powell Coal Company
Reitz Coal Company
Rydesky Mines
Saxman Coal & Coke Company
Seanor Coal Company
Somerset Coal Corporation
Stineman Coal & Coke Company
Vinton Coal & Coke Company
Wieman & Ward Company
Westmoreland Mining Company
Wilmore Coal Company
Wilmore Fuel Company

• WE WILL *be glad to furnish estimates on tests to fit your coal on screen sizes from 5 inches to 200 mesh.*

WARNER LABORATORIES

Member American Council of Commercial Laboratories, Inc.

CRESSON, PA. **PHONE—CRESSON 2302**

Remember this

MERRICK

guarantees

ACCURATE WEIGHT

wherever you

FEED OR CONVEY

Remarkable FEEDOWEIGHT!

A self-contained automatic conveyor scale. Has automatic gate for feed rate control. Feed regulator operates gate, without restraint on scale beam. Feeds bulk material BY WEIGHT; automatically totalizes weight of materials fed. Simple operation. Slow moving parts for long life. Easy to install, maintain.

WEIGHS AND TOTALIZES WHILE CONVEYOR IS RUNNING

WEIGHTOMETER

Gives a continuous automatic, accurate totalized weight record while material is in motion on conveyor. It weighs without interrupting conveyor service. Used with any size belt conveyor, horizontal or inclined. Guarantees an accurate and dependable constant check on production of raw and washed coal, ore, etc.

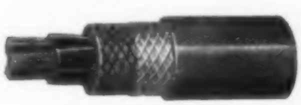
MERRICK SCALE MFG. CO.
Engineers and Mfrs. of Automatic Weighing Equipment
PASSAIC, N. J.

GraybaR...

Electrical equipment and supplies to meet the special needs of the mining industry are an important part of Graybar's all-inclusive service. Located at or near leading mining centers, Graybar offices and warehouses serve as prompt local supply sources for the products of over 300 leading manufacturers. Graybar Representatives in these areas are well informed on underground or above-ground service requirements. Specialists on wiring, lighting, communication, and power apparatus are ready to help you. 430

ELECTRIC CABLE

GRAYBAR offers a complete line of wire and cable for power distribution, for mining machinery and locomotives, shot firing, signaling, and other specialized needs.



Simplex mining machine cable has tough outer selenium-neoprene armor to stand up in mining service.

Tirex shot-firing cable combines flexibility and light weight with high strength.

MOTORS, CONTROLS, FANS

General Electric motors and controls, meeting Bureau of Mines or Underwriters Laboratories requirements for hazardous areas, are available via GRAYBAR as a part of our power apparatus service. Ilg ventilating fans and blowers of all types are also available for mine use.

MINE TELEPHONES

U.S.I. Mine Telephones are sound-powered . . . require no batteries or external power supply. They transmit speech clearly over lines of any length. Supplied for either code or selective signaling up to 24 stations. U.S.I. Mine Telephones carry Bureau of Mines Approval No. 905.

TAPE AND WIRING SUPPLIES

GRAYBAR "Victor" tape is a widely used favorite. Weatherproof sockets, fuses, circuit breakers, panel boards, switches, and terminals are among the many additional wiring supplies distributed by Graybar for electrical systems above ground or below.

LIGHTING EQUIPMENT

Lamps and lighting equipment offered via GRAYBAR include explosion-proof, vaporproof and other specially protected types. Also a full line of floodlights for outdoor service, fluorescents for offices and drafting rooms. Our portables and flashlights are listed by Underwriters Laboratories for Class I, Group D conditions.

Graybar offices and warehouses are located in over 130 principal cities — there's sure to be one near you!

CALL GRAYBAR FIRST FOR . . . *Everything Electrical*

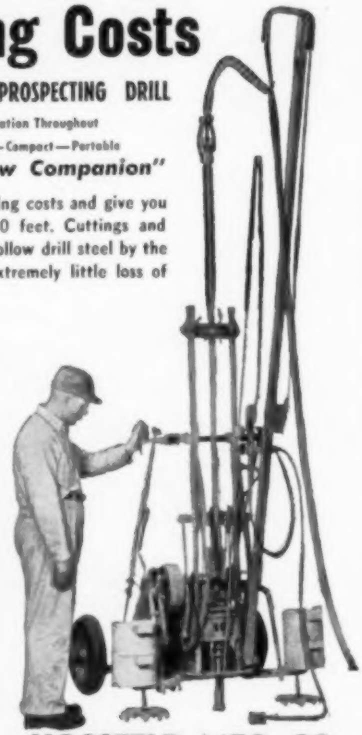
GraybaR ELECTRIC CO., INC.
420 Lexington Avenue, New York 17, N. Y.

Cut Prospecting Costs

GET A Hossfeld Direct Motor Drive PROSPECTING DRILL

- Powerful Direct Drive
- One Man Operation Throughout
- Economical 5 H.P. Air Cooled Engine
- Lightweight—Compact—Portable

"The Prospector's New Companion"



A Hossfeld Prospecting Drill will cut your drilling costs and give you accurate samplings of deposits as deep as 110 feet. Cuttings and water are brought up continually through the hollow drill steel by the bit check valve for assay at any time, with extremely little loss of water, cuttings or salting.

Hossfeld's "Churn" principle, using water to slush the cuttings, makes its possible to drill through various strata from loose or frozen top soil, mud, and slate, through stratas of hard rock. Equipped with pneumatic wheels, the Hossfeld Drill Operators can easily change drilling operations and move from hole to hole.

EASILY TRANSPORTED

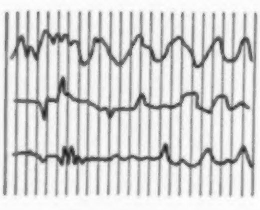
Total Weight: 1,300 lbs. with counterweights. Can be disassembled into 100# units in a very few minutes. Designed for trailer towing, it can be loaded into a half-ton pickup, or trailed in the field on its own chassis behind a car or truck. Or pull it with a burro!

Get all the facts . . . write today for illustrated bulletin giving full details.

HOSSFELD MFG. CO.
444 W. Third St., Winona, Minnesota

NOW- SIMPLE METHOD FOR RECORDING VIBRATIONS

Generated by blasting and industrial operations

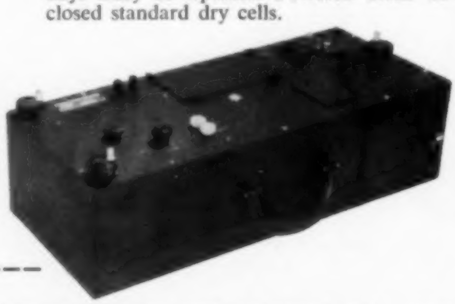


Record of quarry blast.

PERMANENT RECORDS

PORTABLE BLAST and VIBRATION SEISMOGRAPH

This instrument can be set up, levelled, and made ready to operate in a few minutes at any reasonable level location—indoors or out. Vibrations are recorded photographically. Easy to operate. Powered from enclosed standard dry cells.



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W. F. SPRENGNETHER INSTRUMENT CO., INC.
Internationally known Manufacturers of
SEISMOLOGICAL, GEOPHYSICAL, AND ENGINEERING INSTRUMENTS.
4567 SWAN AVENUE SAINT LOUIS 10, MO., U. S. A.

Are You Seeking New Ideas On STRIP MINING?

Be sure to check through pages 76-97 of this Guidebook for the latest developments in:

- Preparing for Operation
- Overburden Preparation
- Stripping
- Coal Loading
- Transportation
- Power
- Drainage

For manufacturers of equipment, materials and supplies used in strip mining, the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Advertisers' Index at the end of this issue. You'll find more useful information in their advertisements.

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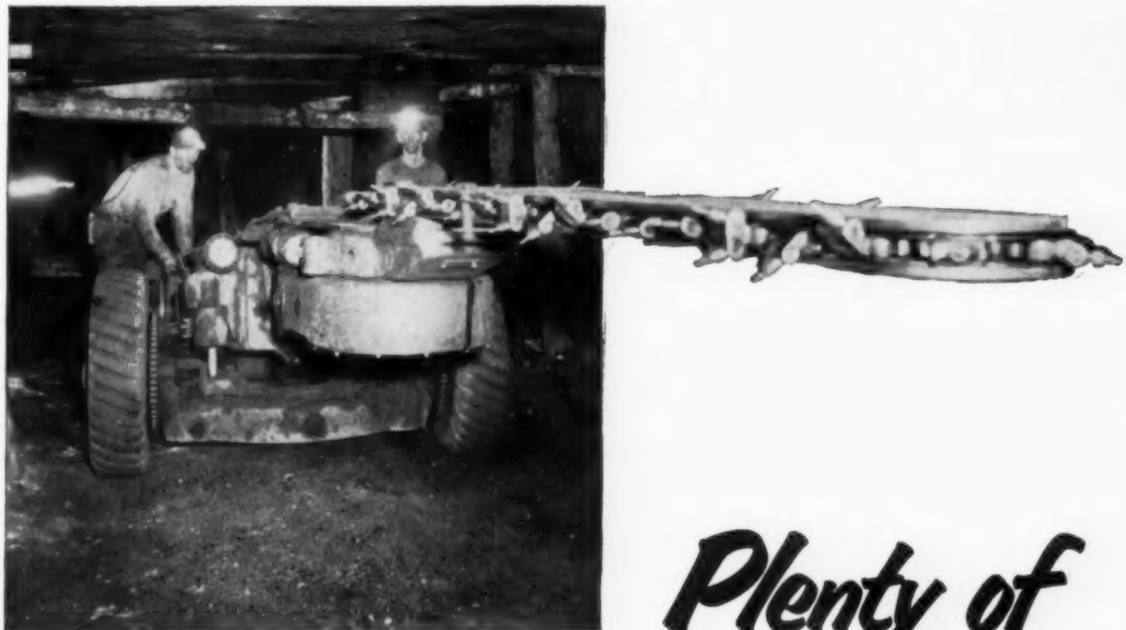
An established annual service for all COAL AGE subscribers



Plenty of Mining Experience
behind these Carbide Bits

CARMET DISTRIBUTORS

Persinger Supply Co., Williamson, W. Va.
Persinger's Inc., Charleston, W. Va.
Leechburg Supply Co., Leechburg, Pa.
Oglebay, Norton & Co., St. Clairsville, Ohio
Drillmaster Supply & Mfg. Co., Evansville, Ind.
Crandall Engineering Co., Inc., Birmingham, Ala.
Carbon Transfer & Supply Co., Helper, Utah
Carlsbad Supply Co., Carlsbad, New Mexico
McCombs Supply Co., Jellico, Tenn.
Union Supply Co., Denver, Colorado
Consolidated Supply Co., Picher, Okla.
W. B. Thompson Co., Iron Mountain, Mich.

★ ★ ★

Write for your copy of the CARMET MINING TOOL CATALOG

This informative 16-page booklet gives complete data, sizes, etc. on all styles of Carmet carbide-tipped cutter and drill bits. Also included is a valuable methods manual on reconditioning methods and equipment. Your copy gladly sent free on request.

ADDRESS DEPT. CA-791

Carmet carbide bits were developed and proved *the hard way* . . . through years of service in every conceivable mining condition and in every mining area. Case histories vary considerably due to local conditions—but no matter what your cutting or drilling problems may be, we can show you records of superior performance by Carmet bits under similar circumstances.

As a direct result of this field-proved background, Carmet bits offer you several distinct advantages. One is the unusually wide range of selection: 15 different styles of cutter bits, 2 styles of finger bits, 2 styles of roof bolting bits, 4 styles of auger bits. More bits to pick from means a closer match with *your* conditions—means savings for you in time and bit costs. Another advantage was *pioneered* by Carmet . . . it's the overlaying cap of steel that double-bonds each carbide cutter tip firmly in its seat, guarding against tip loss and reducing side drag and power consumption.

How about giving Carmet bits a trial? Both we and your local distributor will be glad to cooperate with you. ***Allegheny Ludlum Steel Corp., Carmet Div., Wanda and Jarvis Aves., Detroit 20, Michigan.***

The Original DOUBLE-BONDED Carbide Bit

CARMET® A-L

WSW 6101

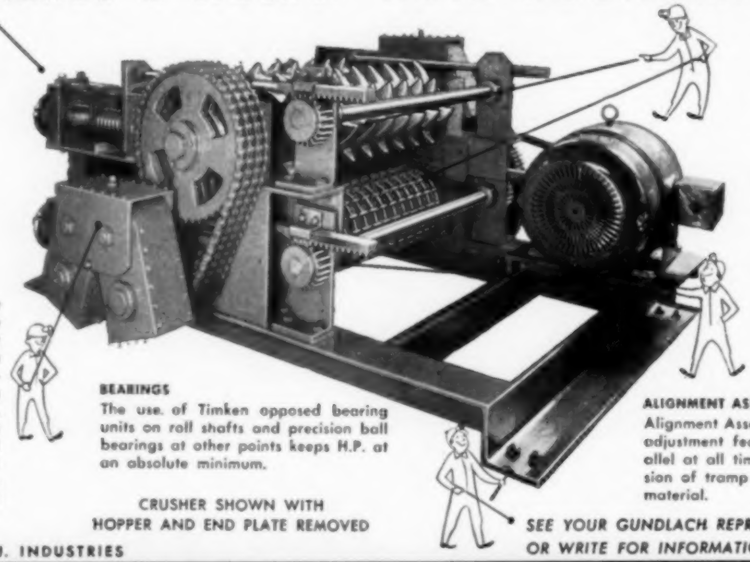
GUNDLACH CRUSHERS

ACCURATE SIZING . . . ECONOMICALLY

What makes a crusher crush ECONOMICALLY?

ADJUSTMENT ASSEMBLY
Upper and lower rolls can be adjusted by a turn of hand wheel while Crusher is in operation. This easy adjustment feature gives operator a definite control of top size of the crushed product . . . between ¾" and 6" top size.

GEAR BOX
The timing of the rolls on each stage is accomplished by means of this unique Gear Box, containing 2 drive gears and 2 idler gears, which are **always in full mesh.** All gears are steel, cut and hardened. Uses self-contained oil splash lubricating.



UPPER ROLLS
Heavy one-piece cast steel construction. Striking sides and surfaces hard-faced with self-hardening rod give added life and decrease maintenance cost.

LOWER ROLLS
Heavy cast steel construction. Each tooth and striking surface hard-faced with self-hardening rod. Pocket-Tooth design gives a negligent percentage of oversize and a minimum of fines.

BEARINGS
The use of Timken opposed bearing units on roll shafts and precision ball bearings at other points keeps H.P. at an absolute minimum.

CRUSHER SHOWN WITH HOPPER AND END PLATE REMOVED

ALIGNMENT ASSEMBLY
Alignment Assembly, interlocked with adjustment feature, keeps rolls parallel at all times, even upon admission of tramp iron or non-crushable material.

SEE YOUR GUNDLACH REPRESENTATIVE OR WRITE FOR INFORMATION

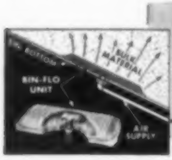
DIVISION OF J. M. J. INDUSTRIES

T. J. GUNDLACH MACHINE CO. 226 CENTREVILLE BELLEVILLE, ILL.

BULK MATERIAL CONTROL
under Pressure or Vacuum

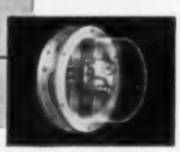
New Roto-Bin-Dicator mounts outside bin, at any angle, for bin level signaling or machinery control. Material loads on paddle actuate Micro switch in motor housing. Flexible paddle shaft permits use with large or lumpy materials when standard diaphragm indicators are impractical.

BIN-FLO AERATOR



Low pressure air diffuser assures steady flow of fine, dry materials that tend to pack in storage.

BIN-DICATOR



The original diaphragm-type bin level indicator for all ordinary applications.

Complete Illustrated Literature FREE

THE BIN-DICATOR CO.
13946-Y1 Kercheval • Detroit 15, Mich.
Phone: VAlley 2-6952

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- Electrical World
- Electronics
- Engineering and Mining Journal
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McGraw-Hill Publishing Co., Inc.
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SIMPLEX MINE JACKS

3 HUSKY MINERS

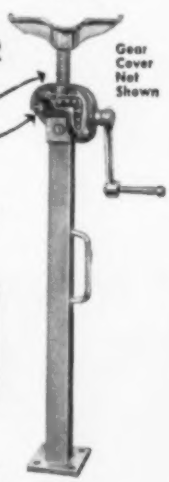
★ Ratchet lowering type for extra safety
★ 5-tons capacity
★ Double-lever sockets permit lifting in close quarters
★ Full capacity on cap OR toe
★ Safety Speed Trigger
★ Ideal for re-railing, repairs, skidding

No. 84A for Thin Seams 14" high, 7" lift

No. 85A for Medium Seams 17" high, 10" lift

No. 86A for Thick Seams 20" high, 13" lift

Hi-Speed TIMBER JACK



Gear Cover Not Shown

Screw Insures Safety

Bevel Gears and Crank Twice as Fast as Lever Nut Type

MODEL No. 642 LIFTS 6 TONS

Combines safety of screw jack with fast action of crank. Head swivels. Five models with min. ht. from 3'6", max. ht. to 9'6".

LIFT — LOWER — PULL — PUSH
— Safely from a Distance

Re-Mo-Trol hydraulic pump and remote controlled ram and puller works in tight spots—in any position. Ram or puller can be operated from 6' or more away. Models from 10 to 100-tons, from 30-tons with famous Simplex "Center-Hole" for easier, safer pulling.

Write for Bulletin Mines 55 for data on the most complete line of Mine Jacks

WORLD'S LARGEST MFGRS. OF INDUSTRIAL MECHANICAL AND HYDRAULIC JACKS

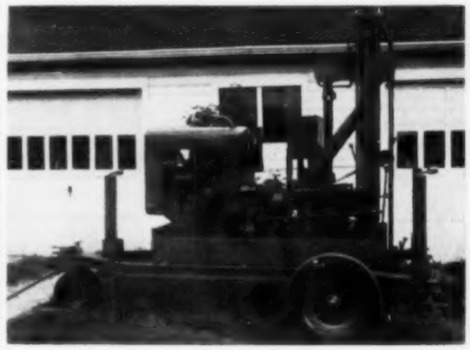
SIMPLEX JACKS
RE-MO-TROL UTIL-A-TOOL JENNY ROL-TOE

TEMPLETON, KENLY & CO.
2501 Gardner Road
Broadview, Illinois

THE PARIS LINE

8 NEW MODELS . . . ALL WORKING . . . FIELD PROVEN . . .

VERTICAL MODELS



Model HV 172
65 h. p. and
109 h. p.

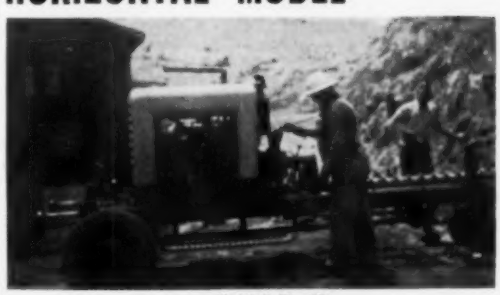
•

Model 51—55
Two Drills in one
109 h. p.

•

also
Model HV-54-PW
Truck Mounted

HORIZONTAL MODEL



Model H 81—53
109 h. p.

PARIS MANUFACTURING CO.
PARIS, ILLINOIS

Typical Installation on Main Haulage

- Rugged.
- Low in Cost.
- Easy to Install
- Increases Production.

"Cheatham Switch"

TRACK SWITCH THROWER ELECTRICALLY OPERATED

This modern track switch is thrown swiftly and safely by motormen as they sit in their cabs. It saves time and money, and is fool-proof and dependable!

Over 50 years experience manufacturing

ELECTRIC TRACK SWITCHES and DERAILS

Write for Catalog

CHEATHAM ELECTRIC SWITCHING DEVICE CO.
INCORPORATED
4780 Crittenden Drive, Louisville, Ky.

NUSSCO AUTOMATIC BLOCK SIGNALS FOR MINES

Save Trip Time on Main Haulage
Prevent Collisions

A two wire cable connects two or more signals together into one block. Only one signal can show proceed on the entrance of a trip, all other signals show stop.

NACHOD & UNITED STATES SIGNAL CO.
INCORPORATED
4771 Louisville Ave., Louisville, Ky.

For Your MINE TRACK Problems

Let us help you with our complete line of—

- Running Skids
- Switch Signal
- Rerailers
- Hinged Derails
- Transition Rails

Write for our new bulletin.

MINERS HARDWARE SUPPLY COMPANY
Republic Bldg., Pittsburgh 12, Pa.

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Don't forget to notify us at least one month in advance to insure uninterrupted service to your subscription to COAL AGE.

Please send your change of address together with your old address to:

DIRECTOR of CIRCULATION
COAL AGE, 330 West 42nd Street
New York 36, N. Y.

DON'T FORGET TO NOTIFY YOUR POSTMASTER, TOO!

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(Classified Advertising)

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GEO. S. BATON & COMPANY
"Founded 1900"
Consulting Engineers
Cost Analysis — Valuations
Mine and Preparation Plant Designs
1100 Union Trust Building Pittsburgh 19, Pa.

MOTT CORE DRILLING CO.
Diamond Core Drilling Contractors
Testing Mineral Deposits
Foundation Borings
Huntington, West Virginia

ALDER F. CASTANOLI
Consulting Mining Engineer
Preparation Problems — Design of New Plants
Modernization of Old Plants
Surface and Underground Plant Design
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HUNTINGTON, WEST VIRGINIA

PAUL WEIR COMPANY
Mining Engineers and Geologists
Consultants and Managers
DESIGN and CONSTRUCTION
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COWIN & COMPANY, INC.
Mining Engineers & Contractors
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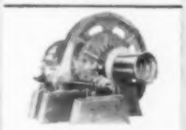
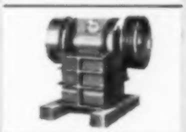
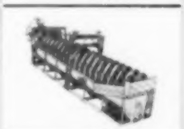
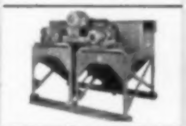
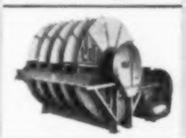
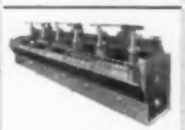
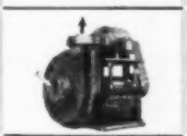
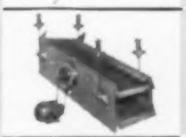
		SIZES		WRITE FOR
DENVER (Patented) **SUPER AGITATORS & CONDITIONERS**		3' x 3' to 20' x 20'	Patented standpipe around propeller shaft assures positive agitation and circulation. Patented weir collar prevents sand-up on shut-down. Heavy-duty as well as acid-proof construction is available.	Bulletin No. A2-B4
DENVER Steel-Head **BALL MILLS**		3' x 2' to 7' x 16'	A Denver Steel-Head Ball Mill will suit your particular need. Five types of discharge trunnions. All-steel construction. Low initial cost due to quantity production. Quick delivery. Laboratory and pilot plant mills also available.	Bulletin No. B2-B13
DENVER Forced-Feed **JAW CRUSHER**		2¼" x 3½" to 36" x 48"	Cast steel frame, manganese jaw and cheek plates. Large diameter shafts reduce shaft deflection and thus increase life of heavy-duty, oversize roller bearings in bumper. Setting easily controlled.	Bulletin No. C12-B12
DENVER Spiral **CLASSIFIER**		6" Simplex to 60" Duplex	Has many improvements. For instance, lower bearing placed above pulp level, arrangement of feed, overflow and direction of rotation result in maximum efficiency. Rake-type and Denver-Finney classifiers also available.	Bulletin No. C5C-B
DENVER Selective **MINERAL JIG**		4" x 6" Simplex to 36" x 48" Duplex	An improved, pulsating, gravity selector that treats unclassified, unsized feed and recovers minerals as soon as freed. Easy to regulate and control, minimum attention. Use in closed grinding circuit or open circuit.	Bulletin No. J2-B10
DENVER Disc **FILTERS**		2' dia. x 1 Disc. to 9' dia. x 8 Disc.	Special, patented design of segments in Denver Disc Filters use both gravity and vacuum to give a drier filter cake. Drainage is complete and positive, with no blow-back. Simple, low-cost, dependable construction. Quick delivery. Also Drum and Pan Filters.	Bulletin No. F9-B2
DENVER "Sub-A" **FLOTATION**		16" x 16" to 55" x 56"	More large plants are installing Denver "Sub-A's" for their entire flotation job — roughing, scavenging, cleaning and re-cleaning — because they give maximum recovery at a low cost per ton. Dependable, low-cost, simplified continuous operation.	Bulletin No. F10-B81
DENVER SRL **SAND PUMPS**		Up to 2400 G.P.M.	Pressure-molded rubber parts, accurately engineered, give high efficiency at low horsepower. DECO also manufactures Denver Vertical Sand Pumps, and Adjustable Stroke Diaphragm Pumps.	Bulletin No. P9-B8
DENVER Automatic **SAMPLERS**		16" to 60" Cutter Travel	Extra rigid track and ball-bearing wheels assure positive travel and timing of sample cutter. Denver Vezin Type, Denver Snyder Type, or complete sampling systems available. Standard, low cost.	Bulletin No. S1-B4
DENVER Dillon **SCREENS**		1' x 3' to 6' x 14'	Gives fast, clean separation without blinding. Gives even, smooth flow of material because of the patented "true-circle" eccentric action. Two bearing construction saves 50% HP.	Bulletin No. S3-B11
DENVER Spiral Rake **THICKENER**		3' x 3' to 125' x 16'	Enclosed, running-in-oil head motion. Patented spiral rakes move settled solids to center discharge with continuous motion, rapid removal of solids tends to eliminate overload. Wood, Steel or rubber-covered Tanks available.	Bulletin No. T5-B5

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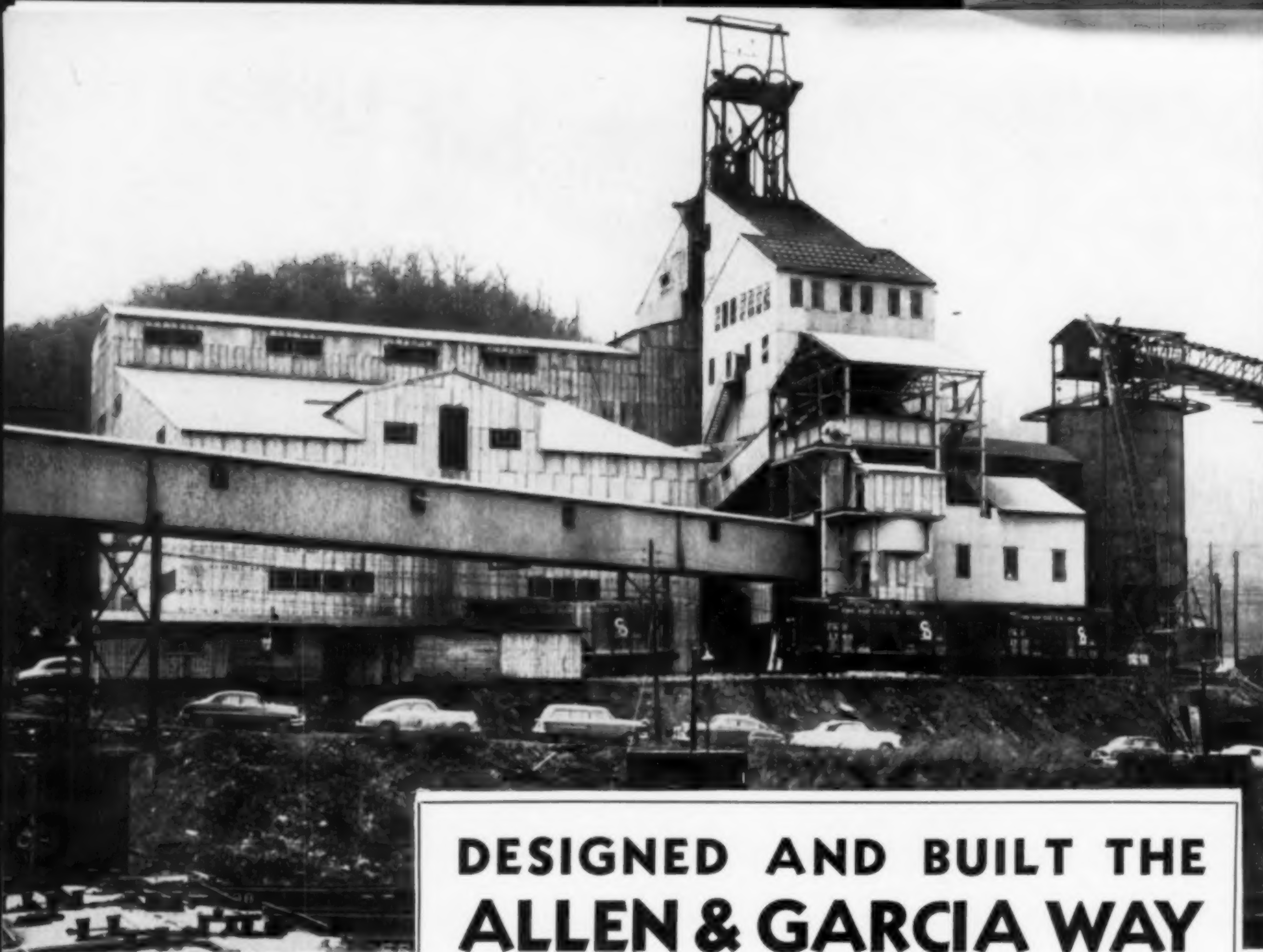

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The 1956 Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

Who Supplies It?

EQUIPMENT, MATERIALS AND SERVICES FOR COAL MINING, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on the next page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearings, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification—for example, "Cable, Welding"—look for the alternative listing—in this instance, "Welding Cable."

TRADE NAMES—Where trade names have been provided by manufacturers, they are shown following the manufacturers' names under the appropriate product headings as an additional aid in locating sources of supply.

PRODUCT INFORMATION—The names of manufacturers and suppliers providing more detailed data on available equipment, materials and services through speed product-information advertisements in this issue are shown in **BLACK-FACED TYPE.** To locate the advertisement of a specific manufacturer, consult the Advertising Index on p 285 of this issue, or the Directory of Manufacturers beginning on p 275.

Where Are They?

THE ADDRESSES of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 275 of this issue.

EXTRA IN 1956—For added convenience in obtaining equipment, services and materials offered by advertisers in this issue, their sales offices and representatives are shown by states in the Advertising Index beginning on p 285.

The 1956 Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

Bold-faced type indicates a product-information advertisement in this issue. To locate, see Advertising Index, p 285, or Directory of Manufacturers, beginning on p 275.

ACETYLENE GENERATORS
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Marathon Coal Bit Co.
Sight Feed Generator Co.—"SIGHT FEED"
Victor Equipment Co.

ACCOUNTING MACHINES
Sperry Rand Corp., Remington Rand Div.
Taller & Cooper

ACTUATORS, CYLINDER, LINE VALVES
Ledeen Mfg. Co.

ADDING MACHINES
Geo-Optic Co., Inc.
Sperry Rand Corp., Remington Rand Div.

ADDITIVES, FUEL-OIL
Warren Refining & Chemical Co.—"PVR"

ADDITIVES, LUBRICANT
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Shell Oil Co.
Sinclair Refining Co.
Stewart-Warner Corp., Alemite Div.
Warren Refining & Chemical Co.—"PVR"

AERATORS, BIN
Bin-Dicator Co.—"BIN-FLO"
Convair

AERIAL PLATFORMS
Pitman Manufacturing Co.—"GIRAFFE"

AERIAL SURVEYING, MAPPING
Aerial Surveys, Inc.
Aero Service Co.
Jack Ammann Photogrammetric Engineers, Inc.
Robert A. Cummings, Jr., & Associates
Fairchild Aerial Surveys, Inc.
Geo-Optic Co., Inc.
Manu-Mine Research & Development Co.

AERIAL TRAMWAYS
Interstate Equipment Div., Yara Engineering Corp.
Robert Holmes & Bros., Inc.
Stearns-Roger Mfg. Co.

AFTERCOOLERS, AIR
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Worthington Corp.

AGITATOR CONDITIONERS
Eimco Corp.
Western Machinery Co.—"WEMCO"

AIR CLEANERS, COAL
Jeffrey Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"
Stephens-Adamson Mfg. Co.—"AIR-SAND"

AIR COMPRESSORS, CENTRIFUGAL
American Blower Corp.

AIR COMPRESSORS, PORTABLE, MINE
Acme Machinery Co.
Cardox Corp.—"AIRDOX"
Gardner-Denver Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"MINEAIR"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Worthington Corp.

AIR COMPRESSORS, PORTABLE, SURFACE
American Brake Shoe Co., Kellogg Div.—"KELLOGG"
Cardox Corp.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
George E. Failing Co.
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.—"UNITAIR," "AIRVANE"
Le Roi Div., Westinghouse Air Brake Co.
Manu-Mine Research & Development Co.
Morse Bros. Machinery Co.
Schramm, Inc.
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Acme Machinery Co.
Davey Compressor Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc.
Worthington Corp.

AIR COMPRESSORS, STATIONARY
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"RO-FLO"
American Brake Shoe Co., Kellogg Div.—"KELLOGG"
Cardox Corp.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
George E. Failing Co.
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"INDUSTRIAL AIR"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Nash Engineering Co.
Ore Reclamation Co.
Penn Machine Co.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.
Worthington Corp.

AIR-LINE FILTERS
Snap-on Tools Corp.

AIR-LINE OILERS
Acme Machinery Co.
Branford Co.—"BRANFORD"
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Mall Tool Co.—"MALL"
R. W. Nichols Co.—"M-B"
Schroeder Bros.
Stewart-Warner Corp., Alemite Div.
Thor Power Tool Co.
Victor Equipment Co.

AIR RECEIVERS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
L. O. Koven & Bros., Inc.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

AIR SEPARATORS, MECHANICAL
Gruendler Crusher & Pulverizer Co.
Hardinge Co., Inc.
Jeffrey Mfg. Co.
Majac, Inc.
Mechanical Industries, Inc.
New Jersey Meter Co.—"DRIAIR"
Universal Road Machinery Co.
Western Precipitation Corp. — MULTI-CLONE"
Williams Patent Crusher & Pulv. Co.

ALARMS, BEARING-TEMPERATURE
The Bristol Co.—"BRISTOL'S"
Femco, Inc.
Foxboro Co.
West Instrument Corp.

ALARMS, TRUCK BACKUP
E. D. Bullard Co.

ALIDADES, PLANETABLE
Kern Instruments, Inc.

ALLOYS, NICKEL
International Nickel Co., Inc.

AMMETERS, CLAMP-ON
Complete Reading Electric Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.
Westinghouse Electric Corp.

AMMETERS, INDICATING
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMETERS, RECORDING
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Westinghouse Electric Corp.

AMMONIUM NITRATE
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Fisher Scientific Co.
Hercules Powder Co.
National Powder Co.
Phillips Petroleum Co.
Spencer Chemical Co.

ANALYZERS, COAL-SULPHUR
Fisher Scientific Co.

ANEMOMETERS
Dietzgen Co., Inc., Eugene
Fisher Scientific Co.
Gurley, W. & L. E.
Keuffel & Esser Co.
Mine Safety Appliances Co.
National Mine Service Co.
Willson Products Div., Ray-O-Vac Co.

ANTI-FOG GOGGLE CLEANER
American Optical Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"FOGPRUF"
U. S. Safety Service Co.—"SAF-I-LENS"
Willson Products Div., Ray-O-Vac Co.

ANTIFREEZE
American Chemsol Co.
American Minechem Co.
American Oil Co.
E. I. du Pont de Nemours & Co., Inc.
Phillips Petroleum Co.
Sinclair Refining Co.

ARCHES, SUSPENDED FURNACE
Bigelow-Liptak Corp.

ARMATURE GROWLERS, TESTERS
Complete Reading Electric Co.
Martindale Electric Co.
Snap-on Tools Corp.

ARMATURE REWINDING
Flood City Brass & Electric Co.
Guyan Machy. Co.
National Mine Service Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

ATHLETE'S-FOOT PREVENTIVE
Onox, Inc.—"ONOX"

ATTRITION MACHINES
Gruendler Crusher & Pulverizer Co.

AUGER EXTENSIONS
Leetonia Tool Co.

AUGER SOCKETS
Leetonia Tool Co.

AUGERS, BREAST
Howells Mining Drill Co.
Marathon Coal Bit Co.
Salem Tool Co.

AUGERS, COAL-RECOVERY
Cardox Corp.
Compton, Inc.
Howells Mining Drill Co.
Link-Belt Co.
Marathon Coal Bit Co.
Salem Tool Co.
Taylor-Wharton Co., Div. Harsco Corp.

AUGERS, COAL-SHOTHOLE
Central Mine Equipment Co.
Dooley Bros.
Drillmaster Supply Co.
Howells Mining Drill Co.
Marathon Coal Bit Co.
McLaughlin Mfg. Co., Inc.
Salem Tool Co.
Schroeder Bros.

AUGERS, EARTH
Central Mine Equipment Co.
Four Wheel Drive Auto Co.
H. & L. Tooth Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Leetonia Tool Co.
Link-Belt Co.
Mall Tool Co.—"MALL"
Marathon Coal Bit Co.
McLaughlin Mfg. Co., Inc.
Pennsylvania Drilling Co.
Salem Tool Co.
Wood Shovel & Tool Co.

AUGERS, ROCK-BLASTHOLE
Drillmaster Supply Co.
Central Mine Equipment Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Marathon Coal Bit Co.
Salem Tool Co.

AXES, MINERS'
Salem Tool Co.

AXLES, CARS, MINE EQUIPMENT
American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Watt Car & Wheel Co.
West Virginia Armature Co.

AXLES, DRIVE, STEERING, AUTOMOTIVE SPECIAL
Clark Equip. Co., Automotive Div.

BACKSTOPS
American Pulley Co.
Barber-Greene Co.
Bonded Scale & Machine Co.
Chain Belt Co.
Continental Gin Co., Industrial Div.
Fairfield Engineering Co.
James Gear Mfg. Co., D. O.
Kremser & Sons, Inc., Frank A.
Marland One-Way Clutch Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Webster Mfg. Co.

BAGS, AIR-FILTER
Bemis Bro. Bag Co.—"STRENGTH-END," "RIPP-NIPP"
C. R. Daniels Co.
Daniels Co. Contractors, Inc.
Ducon Co.
John Flocker & Co.
Koppers Co., Inc., Metal Products Div.
Mechanical Industries, Inc.
National Filter Media Corp.
Western Precipitation Corp.—"DUALAIRE"

BAGS, DISC-FILTER
Eimco Corp.
Peterson Filters & Engineering Co.

BAGS, MULTIWALL
Bemis Bro. Bag Co.—"RIPP-NIPP"

BAGS, POLYETHYLENE
Bemis Bro. Bag Co.—"FLIP-CLOSE"
Eimco Corp.
Peterson Filters & Engineering Co.
Tamping Bag Co.

BAGS, POWDER
American Brattice Cloth Corp.
American Cyanamid Co., Explosives Dept.
Bemis Bro. Bag Co.
C. R. Daniels Co.
E. I. du Pont de Nemours & Co., Inc., Fabrics Div.
Mine Safety Appliances Co.
National Powder Co.
Salem Tool Co.
Tamping Bag Co.

BAGS, TAMPING
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
Bemis Bro. Bag Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Fulton Bag & Cotton Mills
King Powder Co., Inc.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Tamping Bag Co.

BAGS, WATERPROOF
Bemis Bro. Bag Co.

BALLS, STEEL
General Motors Corp., New Departure Div.
SKF Industries, Inc.

BARGE-HANDLING EQUIPMENT
Connellsville Mfg. & Mine Supply Co.
Dravo Corp.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Stephens-Adamson Mfg. Co.

BARGES
Bethlehem Steel Co.
Dravo Corp.
L. O. Koven & Bro., Inc.
Marietta Mfg. Co.
Wiley Mfg. Co.

BAROMETERS
American Paulin System
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.

BAROMETERS, ALTITUDE
Charles Bruning Co., Inc.

BARS, APPLICATOR
Stulz-Sickles Co.—"MANGANAL"

BARS, GRIZZLEY
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"

BARS, SLATE
Duquesne Mine Supply Co.
Leetonia Tool Co.
Pittsburgh Knife & Forge Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Salem Tool Co.

BASKETS, CLOTHES
C. R. Daniels Co.
Moore Co.

BATTERIES, DRY

National Carbon Co. Div., Union Carbide & Carbon Corp.—"EVEREADY"
Phillips Petroleum Co.
United States Rubber Co.

BATTERIES, STORAGE

C & D Batteries, Inc.—"SLYVER-CLAD," "PLASTI CELL," "PLASTI CAL"
Compton, Inc.
Thomas A. Edison, Inc., Edison Storage Battery Div.—"EDISON"
Exide Industrial Div., Electric Storage Battery Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
K. W. Battery Co., Inc.
Kersey Mfg. Co., Inc.
National Mine Service Co.
Phillips Petroleum Co.
Seiberling Rubber Co.
United States Rubber Co.
Yardney Electric Corp.—"YARDNEY SILVERCEL," "YARDNEY SILCAD"

BATTERY-CHARGING EQUIPMENT

Cornell-Dubilier Electric Co.
Electric Products Co.
Exide Industrial Div., Electric Storage Battery Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
General Scientific Equipment Co.
Gould-National Batteries, Inc.
Hobart Bros. Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
K. W. Battery Co., Inc.
Kersey Mfg. Co., Inc.
Lincoln Electric Co. — "PRECISION-CHARGE"
Mine Safety Appliances Co.
Syntron Co.—"POWERTRONIC"
Westinghouse Electric Corp.

BATTERY TEST CLAMPS

General Scientific Equipment Co.
Graybar Elec. Co., Inc.

BEARING METAL

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Crucible Steel Co. of America
Imperial-Cantrell Mfg. Co.—"IC"
Johnson Bronze Co.
Joseph T. Ryerson & Son, Inc.
Webster Mfg. Co.
West Virginia Armature Co.

BEARING OILERS

Herold Mfg. Co.

BEARINGS, BALL

Ahlberg Bearing Co.—"AHLBERG"
Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Complete Reading Electric Co.
Continental Gin Co., Industrial Div.
Cooke-Wilson Electric Supply Co.
Dodge Mfg. Corp.—"SC," "SLP," "SCM"
Ensign Electric & Mfg. Co.
Fafnir Bearing Co.
Federal Bearings Co., Inc.
Flood City Brass & Electric Co.
General Motors Corp., New Departure Div.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Link-Belt Co.—"JPS"
Marlin-Rockewell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
New Departure Div., General Motors Corp.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Ore Reclamation Co.
Stephens-Adamson Mfg. Co. — "SEAL-MASTER"
Torrington Co.
Transall, Inc.
T. B. Woods Sons Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BEARINGS, BRONZE

American Brake Shoe Co., National Bearing Div.

BEARINGS, CARBON

Helwig Co.
Ohio Carbon Co.—"KARAK"
Pure Carbon Co., Inc.

BEARINGS, JOURNAL

American Brake Shoe Co., National Bearing Div.

BEARINGS, NEEDLE

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
McGill Mfg. Co., Inc. — "MULTIROL," "CAMROL," "GUIDEROL"
Orange Roller Bearing Co., Inc.
Torrington Co.
Westinghouse Electric Corp.

BEARINGS, ROLLER

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.
Complete Reading Electric Co.
Continental Gin Co., Industrial Div.
Cooke-Wilson Electric Supply Co.
Dodge Mfg. Corp.—"DODGE-TIMKEN"
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co.
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Norma-Hoffmann Bearing Corp.
Orange Roller Bearing Co., Inc.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Timken Roller Bearing Co.
Torrington Co.
Tyson Bearing Corp., Sub. SKF Industries, Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.

BEARINGS, ROLLER, SPLIT

Bearing Service Co.
Bearings, Inc.
Enterprise Wheel & Car Corp.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co.
Transall, Inc.

BEARINGS, SLEEVE

American Crucible Products Co.
Allison Div., General Motors Corp.
American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Complete Reading Electric Co.
Dodge Mfg. Corp.—"SLEEVOIL"
Flood City Brass & Electric Co.
Imperial-Cantrell Mfg. Co.—"I C"
Johnson Bronze Co.
Keystone Carbon Co.
Link-Belt Co.—"LINK-BELT"
Mosebach Electric & Supply Co.
Saginaw Bearing Co.—"SABECO"
Bertrand P. Tracy Co.
Transall, Inc.
Webster Mfg. Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BEARINGS, SLEEVE, CONVERSION

Bearings, Inc.
Imperial-Cantrell Mfg. Co.—"I C"
Johnson Bronze Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BEARINGS, THRUST

Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Continental Gin Co., Industrial Div.
General Motors Corp., New Departure Div.
Gibraltar Equipment & Mfg. Co.
Federal Bearings Co., Inc.
Hyatt Bearings Div., General Motors Corp.
Jeffrey Mfg. Co.
Johnson Bronze Co.
Link-Belt Co.
Marlin-Rockewell Corp.—"M-R-C"
New Departure Div., General Motors Corp.
Norma-Hoffmann Bearing Corp.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Saginaw Bearing Co.—"SABECO"
Torrington Co.

BELT-LOADING STATIONS, AUTOMATIC

Nolan Co.

BELTS, FLAT TRANSMISSION

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co.
C. R. Daniels Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div. —"HIGH FLEX"
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"SUPER SERVICE"
Hewitt-Robins, Inc.
Manheim Mfg. & Belting Co.
New York Belting & Packing Co.—"TEST SPECIAL," "GILMER," "KABLE KORD"
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"CHALLENGER"
Scandinavia Belting Co.
Talcott, Inc.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
Transall, Inc.
United States Rubber Co.

BELTS, V

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEXROPE"
American Pulley Co.—"WEDGBELT"
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Complete Reading Electric Co.
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"SEALED-LIFE"
Flexible Steel Lacing Co.
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Guyan Machy. Co.
Link-Belt Co.

Mosebach Electric & Supply Co.
National Mine Service Co.
New York Belting & Packing Co.—"GILMER"
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC"
Thermoid Co., Industrial Div.
Transall, Inc.
United States Rubber Co.
T. B. Woods Sons Co.
Worthington Corp.

BELTS, V-LINK

Guyan Machy. Co.
Manheim Mfg. & Belting Co.
National Mine Service Co.
New York Belting & Packing Co.—"GIL-LINK"
T. B. Woods Sons Co.

BENDERS, PIPE, CONDUIT

Blackhawk Mfg. Co.
Hossfeld Mfg. Co.—"HOSSFELD UNIVERSAL"
National Electric Products Co.

BILLING MACHINES

Sperry Rand Corp., Remington Rand Div.

BINDERS, LOAD

American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Coffing Hoist Div., Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.
Pittsburgh Knife & Forge Co.

BIN GATES

Atlas Car & Mfg. Co.
B-I-F Industries, Inc.
Bartlett, C. O., & Snow Co.
Blaw-Knox Co.
C. S. Card Iron Works
Chain Belt Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Kanawha Mfg. Co.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Mechanical Industries, Inc.
Meckum Engr. Co.
Ore Reclamation Co.
Pioneer Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works—"TELSMITH"
Stephens-Adamson Mfg. Co.—"SIMPLEX MOORE," "DUPLEX," "TRIPLEX"
Straub Mfg. Co., Inc.
Thomas Engineering & Construction Co.
Transall, Inc.
Webster Mfg. Co.
Wilmot Engineering Co.

BIN-LEVEL INDICATORS

Bin-Dicator Co.—"BINDICATOR," "BANTAM BINDICATOR," "ROTO BINDICATOR"
Convair
Fairfield Engineering Co.
Hewitt-Robins, Inc.—"ROBINTRONIC"
Jeffrey Mfg. Co.
Stephens-Adamson Mfg. Co.—"TELLEVEL"
Transall, Inc.

BIN VIBRATORS

Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Mfg. Co.
Jeffrey Mfg. Co.
W. S. Tyler Co.—"TY-SPEED"

BINS, PARTS-STORAGE

Complete Reading Electric Co.
Frick-Gallagher Mfg. Co.
Kanawha Mfg. Co.
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.

BINS & HOPPERS, COAL-STORAGE, BLENDING

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Barber-Greene Co.
Nelson L. Davis Co.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Kanawha Mfg. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
L. O. Koven & Bro., Inc.
Link-Belt Co.
Meckum Engr. Co.
R. C. Mahon Co.
Marietta Concrete Corp.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Neff & Fry Co.
Ore Reclamation Co.
Pioneer Engineering Works
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Thomas Engineering & Construction Co.
Transall, Inc.
Universal Engineering Co.

BITS—See Cutter Bits, Drill Bits

BIT BOXES

Duquesne Mine Supply Co.

BIT SHARPENERS, COAL BITS

Carboloy Dept., General Electric Co.
Herold Mfg. Co.
Joy Mfg. Co.

BIT SHARPENERS, ROCK BITS

Bucyrus-Erie Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Stardrill-Keystone Co.—"ACME"

BIT-SHARPENING SERVICE

Brunner & Lay, Inc.
Drillmaster Supply Co.
Howells Mining Drill Co.
Marathon Coal Bit Co.

BIT-SHARPENING SERVICE, DIAMOND

Drillmaster Supply Co.
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
J. K. Smit & Sons
Sprague & Henwood

BLASTING AGENTS

American Cyanamid Co., Explosives Dept.—"CYAMITE," "CYAMON"
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"NITRAMEX," "NITRAMITE," "NITRAMON"
Hercules Powder Co.
Illinois Powder Mfg. Co.
King Powder Co., Inc.

BLASTING CAPS

American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
Illinois Powder Mfg. Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

BLASTING MACHINES

American Cyanamid Co., Explosives Dept.

BLASTING WIRE, CORD

American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
Cornish Wire Co., Inc.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Electrical Wire & Cable Dept., United States Rubber Co.
General Electric Co., Construction Materials Dept.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Salem Tool Co.

BLOCK SIGNALS, AUTOMATIC

American Mine Door Co.

BLOCKS, MANILA-ROPE

Upson-Walton Co.

BLOCKS, WHEEL

Aldon Co.

BLOCKS, WIRE-ROPE

American Brake Shoe Co., Amsco Div.
American Hoist & Derrick Co.—"CROSBY"
George E. Failing Co.
Guyan Machy. Co.
Joy Mfg. Co.
Sauerman Bros., Inc.—"DUROLITE"
Upson-Walton Co.

BLOWERS, CENTRIFUGAL

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Blower Corp.
Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Chelsea Products, Inc.
Clarage Fan Co.
Complete Reading Electric Co.
Coppus Engineering Corp.
DeLaval Steam Turbine Co.
Graybar Elec. Co., Inc.
Hartzell Propeller Fan Co.
Ilg Electric Ventilating Co.—"ILG"
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Mechanical Industries, Inc.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
U. S. Hoffman Machinery Corp., Industrial Div.
Westinghouse Electric Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, CIRCULATING, DRAFT

Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Clarage Fan Co.
Complete Reading Electric Co.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.—"AXIVANE"
Sanford Day Iron Works, Inc.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, CLEANING, MAINTENANCE

American Mine Door Co.
Complete Reading Electric Co.
Holub Industries, Inc.
Joy Mfg. Co.—"AXIVANE"
Martindale Electric Co.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, JIG

Roots-Connersville Blower, Div. Dresser Industries, Inc.

BLOWERS, PORTABLE, MINE

American Blower Corp.
Buffalo Forge Co.
Chelsea Products, Inc.

Coppus Engineering Corp. — "VANO," "VENTAIR"
Herold Mfg. Co.
Jeffrey Mfg. Co.—"AERODYNE"
Joy Mfg. Co.—"AXIVANE"
Mine Safety Appliances Co.
Morse Bros. Machinery Co.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLUE, PHOTO & WHITE PRINTING EQUIPMENT, MATERIALS
Keuffel & Esser Co.

BOILERS, HEATING, HOT-WATER
Axeman-Anderson Co.
L. O. Koven & Bro., Inc.

BOLT-HOLE CLEANERS
Mine Safety Appliances Co.—"M-S-A"

BOLTS
Bayonne Bolt Corp.
Bethlehem Steel Co.
Duquesne Mine Supply Co.—"REDIPT"
J. V. Hammond Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Maryland Bolt & Nut Co.
Oliver Iron & Steel Corp.
Pattin Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
St. Louis Screw & Bolt Co.
Sheffield Steel Div., Armco Steel Corp.

BOLTS, TRACK—See Rail Bolts

BONDS, RAIL—See Rail Bonds

BOX-CAR LOADERS
Eimco Corp.
Lippmann Engrg. Works
Morse Bros. Machinery Co.
Stephens-Adamson Mfg. Co. — "SWIVELOADER," "SINDEN"

BOXES, DETONATOR
J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BOXES, POWDER
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BOXES, POWDER, SAFETY WOOD
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BRACES, TRACK
Gibralter Equipment & Mfg. Co.

BRAKE BLOCKS
Irwin Foundry & Mine Car Co.
Johns-Manville
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Co. Industrial Div.
Wagner Electric Corp.
S. K. Wellman Co.

BRAKE BLOCKS, WOOD
Enterprise Wheel & Car Corp.
J. V. Hammond Co.
Irwin Foundry & Mine Car Co.

BRAKE FLUID, HYDRAULIC
United States Rubber Co.

BRAKE FRICTION, LINING
American Brake Shoe Co., American Brake Block Div.
Duquesne Mine Supply Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Johns-Manville
Mining Machine Parts Inc.
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Co. Industrial Div.
Wagner Electric Corp.
S. K. Wellman Co.

BRAKE SHOES, METALLIC
American Brake Shoe Co., Brake Shoe & Castings Div.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.
National Mine Service Co.
West Virginia Armature Co.

BRAKES, LOCOMOTIVE
Flood City Brass & Electric Co.
Goodyear Tire & Rubber Co.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.

BRAKES, MAGNETIC
Clark Controller Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
General Electric Co. Apparatus Sales Div.
Square D Co.
Stearns Magnetic, Inc.
Trombetta Solenoid Corp.
Westinghouse Electric Corp.

BRAKES, MAGNETIC, EDDY-CURRENT
Dynamatic Div. Eaton Mfg. Co.
Square D Co.

BRAKES, MINE-CAR
American Car & Foundry Div. ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibralter Equipment & Mfg. Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.

BRAKES, TRUCK, AIR
Eaton Mfg. Co., Axle Div.
Four Wheel Drive Auto Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Wagner Electric Corp.

BRAKES, TRUCK, HYDRAULIC
Four Wheel Drive Auto Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Wagner Electric Corp.

BRAKES, TRUCK, MECHANICAL
American Chain & Cable Co., Inc.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

BRAKES, LININGS
S. K. Wellman Co.

BRAKES, LOWERING-CONVEYOR
Vulcan Iron Works

BRATTICE CLOTH
American Brattice Cloth Corp.
C. R. Daniels Co.
John Flocker & Co.—"MOROPA"
Fulton Bag & Cotton Mills General Office, Bag Div.—"BLAZE BREAKER," "FFFF"
Goodrich Co., B. F., Industrial Products Div.
National Mine Service Co.

BREAKERS, AIR-PICK, FOR COAL
Le Roi Div., Westinghouse Air Brake Co.

BREAKERS, COAL REVOLVING
American Steel Foundries—"WEARPACT"
Crusher Engineering Div., Poor & Co.
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.

BREAKERS, PICK-TYPE, PREPARATION
McNally-Pittsburg Mfg. Corp.

BREAKERS, COAL, TWO-STAGE
Crusher Engineering Div., Poor & Co.

BREAKERS, PAVING
Athey Products Corp.
Cleco Div., Reed Roller Bit Co.
Gardner-Denver Company
Homelite, Div. Textron American, Inc.—"HOMELITE (BOSCH)"
Ingersoll-Rand Co.
Joy Mfg Co.
Le Roi Div. Westinghouse Air Brake Co.
Marathon Coal Bit Co.
Thor Power Tool Co.

BREATHING APPARATUS
Mine Safety Appliances Co.—"CHEMOX," "McCAA TWO-HOUR"

BRIDGES, COAL HANDLING
Heyl & Patterson, Inc.
Dravo Corp.

BRUSH HOLDERS
Complete Reading Electric Co.
Cooke-Wilson Electric Supply Co.
D. B. Flower Mfg. Co.—"FLOWER"
Helwig Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BRUSHES, CARBON
Complete Reading Electric Co.
Cooke-Wilson Electric Supply Co.
Flood City Brass & Electric Co.
Guyan Machy. Co.
Helwig Co.
Keystone Carbon Co.
National Carbon Co., Div. of Union Carbide & Carbon Corp.
National Mine Service Co.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Speer Carbon Co.
Stackpole Carbon Co.
Standard Carbon Co.
Superior Carbon Products, Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.

BUCKET CHAINS, DRAGLINE
American Brake Shoe Co., Amsco Div. "AMSCO"

BUCKET TEETH, BASES, INSERTS
American Brake Shoe Co., Amsco Div.
American Steel Foundries—"WEARPACT"
Blaw-Knox Co.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
H. & L. Tooth Co.
Kensington Steel Co.
Page Engineering Co.
Taylor-Wharton Co., Div. Harsco Corp.

BUCKET-TEETH REPOINTERS
American Brake Shoe Co., Amsco Div.

BUCKETS, AERIAL TRAMWAY
Robert Holmes & Bros., Inc.

Irwin Foundry & Mine Car Co.
Watt Car & Wheel Co.

BUCKETS, CLAMSHELL

Blaw-Knox Co.
Electric Steel Foundry Co.
L. B. Foster Co.
George Haiss Mfg. Co., Div. Pettibone Mulliken Corp.
Industrial Brownhoist Corp.
Koehring Co.
Orton Crane & Shovel Co.
Pettibone Mulliken Co.
Quick-way Truck Shovel Co.
Salem-Brosius, Inc.
Schield Bantam Co.
Wellman Engineering Co.

BUCKETS, CONVEYOR, ELEVATOR

American Brake Shoe Co., Amsco Div.
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Enterprise Wheel & Car Corp.
Fairfield Engineering Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robbins, Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Laubenstein Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
Pioneer Engineering Works
K. Prins & Associates
Remaly Mfg. Co.
W. J. Savage Co.
Smith Engineering Works
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Engineering Co.
Universal Road Machinery Co.
Watt Car & Wheel Co.
Webster Mfg. Co.
Wilmot Engineering Co.

BUCKETS, DRILL-DUST

Mine Safety Appliances Co. — "DRIL-DUST"

BUCKETS, DRAGLINE

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Hendrix Mfg. Co.
Page Engineering Co.
Pettibone Mulliken Co.
Quick-Way Truck Shovel Co.
Remaly Mfg. Co.
Sauerman Bros., Inc.
Schield Bantam Co.
Taylor-Wharton Co., Div. Harsco Corp.
Wellman Engineering Co.,

BUCKETS, DRAGLINE—ARCHES, CHAINS, FITTINGS

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Hendrix Mfg. Co.
Page Engineering Co.

BUCKETS, DUMP

Salem-Brosius, Inc.

BUGDUSTERS, AUTOMATIC

Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.

BUILDINGS, PREENGINEERED, STEEL, ALUMINUM

Butler Mfg. Co.

BUILDINGS, PREFAB

Armco Drainage & Metal Prod., Inc.
Arrowhead Steel Buildings, Inc.
Manu-Mine Research & Development Co.
Republic Steel Corp.—"TRUSCON"
Steel-Bilt Construction Co.
Steelcraft Mfg. Co.
Thomas Engineering & Construction Co.

BULLDOZER CORNER BITS

American Brake Shoe Co., Amsco Div.

BULLDOZER & GRADER BLADES

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.
American Steel Foundries—"WEARPACT"
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Electric Steel Foundry Co.
Gar Wood Industries, Inc.
The Frank G. Hough Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.
Oliver Corp.—"OLIVER"

BULLDOZER RIPPER TEETH

American Brake Shoe Co., Amsco Div.

BULLDOZERS

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Eimco Corp.
Euclid Division, General Motors Corp
L. B. Foster Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR"

BULLETIN-BOARD SERVICE

Elliott Service Co., Inc.

BUMPERS, LOCOMOTIVE

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Thomas Engineering & Construction Co.
West Virginia Armature Co.

BUMPERS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.
Thomas Engineering & Construction Co.
Watt Car & Wheel Co.
West Virginia Armature Co.

BUSES, ELECTRIC

Delta-Star Electric Div., H. K. Porter Co., Inc.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

BUSHINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Complete Reading Electric Co.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Imperial-Cantrell Mfg. Co.—"IC"
Jeffrey Mfg. Co.
Johnson Bronze Co.
Keystone Carbon Co.
Marathon Coal Bit Co.
Penn Machine Co.
Saginaw Bearing Co.—"SABECO"
Bertrand P. Tracy Co.
Walworth Co.

BUSHINGS, ELECTRICAL

Imperial-Cantrell Mfg. Co.—"IC"
National Electric Products Co.
Ohio Brass Co.
Superior Carbon Products, Inc.
West Virginia Armature Co.

BUSHINGS, RUBBER

United States Rubber Co.

CABLE, ALUMINUM

Reynolds Metals Co.
Aluminum Co. of America

CABLE, ARMORED

Rockbestos Products Corp.

CABLE, ASBESTOS—COVERED

American Steel & Wire Div., United States Steel Corp.—"AMERBESTOS"
Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.—"SAFETY M1"
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Products Corp.—"ROCKBESTOS A.V.C."
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Triangle Conduit & Cable Co.

CABLE, FEEDER, BARE, STRANDED

Aluminum Company of America
American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Cooke-Wilson Electric Supply Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.
Triangle Conduit & Cable Co.

CABLE, FEEDER, COPPER AND COPPER CLAD, BARE AND STRANDED

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
National Mine Service Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.
Triangle Conduit & Cable Co.

CABLE INSULATED, BOREHOLE

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Cooke-Wilson Electric Supply Co.
Electrical Wire & Cable Dept., United States Rubber Co.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
National Mine Service Co.
Okonite Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE, INSULATED, COMMUNICATION, CONTROL

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.—"ANKOSEAL"
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.
Electrical Wire & Cable Dept., United States Rubber Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
Femco, Inc.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
National Electric Products Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE, INSULATED, HIGH-VOLTAGE DISTRIBUTION

Aluminum Company of America
American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.—"ANKOSEAL"
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp. — "GENCORONE," "BUTARONE"
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
The Kerite Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE, INSULATED, LOW-VOLTAGE DISTRIBUTION AC AND DC

Aluminum Company of America
American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.—"ANKOSEAL"
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.—"SUPERSHEATH," "GUARDIAN"
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
The Kerite Co.
Mosebach Electric & Supply Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE, INSULATED, SUBMARINE

American Steel & Wire Div., United States Steel Corp.—"AMARINE"
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.—"ANKOSEAL"
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE, LEAD-SHEATHED

Rockbestos Products Corp.

CABLE, SHOTFIRING

American Cyanamid Co., Explosives Dept.
American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Cooke-Wilson Electric Supply Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
King Powder Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Salem Tool Co.
Simplex Wire & Cable Co.

CABLE, TELEPHONE

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.—"ANKOSEAL"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Electrical Wire & Cable Dept., United States Rubber Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Corp.

CABLE, TRAILING, 2,200 V AND UP

American Steel & Wire Div., United States Steel Corp.—"AMERCLAD"
Anaconda Wire & Cable Co.
Electrical Wire & Cable Dept., United States Rubber Co.—"U. S. ROYAL"
John Flocker & Co.
General Cable Corp.—"SUPERSERVICE"
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Simplex Wire & Cable Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Triangle Conduit & Cable Co.

CABLE, TRAILING, UNDERGROUND MINING UNITS

American Steel & Wire Div., United States Steel Corp.—"AMERCLAD"
Anaconda Wire & Cable Co.
Cooke-Wilson Electric Supply Co.
Collyer Insulated Wire Co.
Electrical Wire & Cable Dept., United States Rubber Co.—"U. S. LATEX ROYAL MASTER"
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.—"SUPERSERVICE"
General Electric Co., Construction Materials Dept.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.

CABLE ACCESSORIES, HIGH VOLTAGE

Delta-Star Electric Div., H. K. Porter Co., Inc.
G & W Electric Specialty Co.
Graybar Elec. Co., Inc.
Ohio Brass Co.

CABLE CLAMPS

American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ohio Brass Co.
Ore Reclamation Co.

CABLE CONNECTORS, ELECTRICAL

Anaconda Wire & Cable Co.
Albert & J. M. Anderson Mfg. Co. — "EITHEREND"
Burndy Engrg. Co., Inc. — "HYLLIGS," "HYLINKS"
Crouse-Hinds Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Erico Products, Inc.—"CADWELD"
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Joy Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Ohio Brass Co.
Tweco Products, Inc.—"SOL-CON," "MEC-CON"
West Virginia Armature Co.

CABLE FAULT-FINDERS, PROOF TESTERS

Electrical Distributors Co.

CABLE HANGERS

Graybar Elec. Co., Inc.
Ohio Brass Co.

CABLE REELS, LOCOMOTIVE

General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
West Virginia Armature Co.

CABLE REELS, MINING-MACHINE, SHUTTLE CAR

Dooley Brothers
Jeffrey Mfg. Co.

CABLE REELS, SHOTFIRING

King Powder Co., Inc.

CABLE, TRAILING, SHOCK ABSORBERS

Mosebach Electric & Supply Co.

CABLE SPLICERS
American Mine Door Co.—"QUICK-ON"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.—"VELOCITY-POWER"
Minnesota Mining & Mfg. Co.—"SCOTCH-CAST"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Tweco Products, Inc.—"TWECO"
West Virginia Armature Co.

CABLE VULCANIZERS
American Mine Door Co.
Flood City Brass & Electric Co.
Joy Mfg. Co.
Mine Safety Appliances Co.
Mosebach Electric & Supply Co.

CABLE SUPPORTS, BOREHOLE
Ohio Brass Co.

CABLE SUPPORTS, HORIZONTAL RUNS
Delta-Star Electric Div., H. K. Porter Co., Inc.
The Elreco Corp.—"ELRECO"
Ohio Brass Co.

CAGERS, CAGING EQUIPMENT
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.
The Nolan Co.
Robert & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CAGES
C. S. Card Iron Works
Connellsville Mfg. & Supply Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
The Nolan Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Vulcan Iron Works

CAGES, ELEVATOR-TYPE
Connellsville Mfg. & Mine Supply Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Mayo Tunnel & Mine Equipment Co.

CALCIUM CHLORIDE
Columbia-Southern Chemical Corp.
The Dow Chemical Co.—"DOWFLAKE," "PELADOW"
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Fuel Process Co.
Sight Feed Generator Co.
Solvay Sales Div., Allied Chemical & Dye Corp.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CALCULATORS
Sperry Rand Corp., Remington Rand Div.

CANVAS
Bemis Bro. Bag Co.

CAPACITORS
Allen-Bradley Co.
Complete Reading Electric Co.
Cornell-Dubilier Electric Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

CAP-LAMP CHARGERS
Mine Safety Appliances Co.
National Mine Service Co.

CAP-LAMP RACKS
Mine Safety Appliances Co.
National Mine Service Co.

CAP LAMPS
Mine Safety Appliances Co.—"EDISON R4"
National Mine Service Co.

CAR DUMPERS
Atlas Car & Mfg. Co.

CAR BY-PASSERS
American Mine Door Co.

CAR DUMPERS, R. R. ROTARY
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Link-Belt Co.—"LINK-BELT"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Vulcan Iron Works
Wellman Engineering Co.

CAR HAULS, MOVERS, PULLERS, R. R.
Aldon Co.
Advance Car Mover Co., Inc.—"BADGER," "NEW BADGER," "POWER KING," "POWER BOY"
American Engineering Co.
Bartlett, C. O., & Snow Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins, Inc.
Robelt Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webster Mfg. Co.
Whiting Corp.

CAR HAULS, MINE
Nolan Co.

CAR HAULS, MOVERS, SPOTTERS, MINE
Aldon Co.
Connellsville Mfg. & Mine Supply Co.
Nelson L. Davis Co.
Fairmont Machinery Co.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Morse Bros. Machinery Co.
Sanford Day Iron Works, Inc.
Schroeder Bros.
W. R. Stanler Corp.—"STAMLER"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webster Mfg. Co.
Wilmot Engineering Co.

CAR HOLDS, STOPS, MINE
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Duquesne Mine Supply Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanakha Mfg. Co.
The Nolan Co.

CAR RETARDERS, MINE CAR
Connellsville Mfg. & Mine Supply Co.
Nelson L. Davis Co.
Fairmont Machinery Co.
L. B. Foster Co.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
The Nolan Co.
Sanford Day Iron Works, Inc.
Webster Mfg. Co.

CAR RETARDERS, R. R.
L. B. Foster Co.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
McNally-Pittsburg Mfg. Corp.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Webster Mfg. Co.

CAR SHAKERS, R. R.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Hewitt-Robins, Inc.
Link-Belt Co.—"LINK-BELT"
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co. — "CAR-QUAKE"
Webster Mfg. Co.

CAR SPOTTERS
Nolan Co.—"PORTA-FEEDER"

CAR STOPS
Nolan Co.

CAR STOPS, ELECTRIC
Cheatham Elec. Switching Device Co.
Gibraltar Equipment & Mfg. Co.
Robert Holmes & Bros., Inc.

CAR THAWERS
Hauck Mfg. Co.

CAR TRANSFERS, MINE
American Mine Door Co.—"CANTON"
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
L. B. Foster Co.
Robert Holmes & Bros., Inc.

CARBON BLACK
Fisher Scientific Co.
Phillips Petroleum Co.
R. T. Vanderbilt Co.

CARBIDE METALS, SINTERED
Allegheny Ludlum Steel Corp.

CARRIERS, MINE EQUIPMENT
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.

CARRIERS, SHUTTLE-CAR
Salem-Brosius, Inc.—"PHIL-DOLLY"

CARS, BALLAST
Differential Steel Car Co.

CARS, RAIL, AIR-DUMP
C. S. Card Iron Works
Differential Steel Car Co.

CARS, RAIL, MINE
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.

Sanford Day Iron Works, Inc.
U. S. Steel Corp.
Watt Car & Wheel Co.

CARS, RAIL, MAN-TRIP
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.—"MAN-VAN"
Lee-Norse Co.—"MINE PORTAL BUS"
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, PERSONNEL, SELF-PROPELLED
Acme Machinery Co.
Irwin Foundry & Mine Car Co.
Lee-Norse Co.—"JITNEY," "SCOOTER"

CARS, RAIL, SUPPLY
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Mayo Tunnel & Mine Equipment Co.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, TOOL & REPAIR, SELF-PROPELLED
Joy Mfg. Co.

CARS, RUBBER-TIRED, COAL, SELF-PROPELLED
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Prime Mover Co.—"M30 PRIME MOVER"

CARS, RUBBER-TIRED, MEN & SUPPLIES, SELF-PROPELLED
Joy Mfg. Co.
Kanawha Mfg. Co.
Lee-Norse Co.—"UTILITY TRUCK"
Prime Mover Co.—"M30 PRIME MOVER"

CARS, RUBBER-TIRED TRAILING, COAL
Goodman Mfg. Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.

CARS, RUBBER-TIRED TRAILING, MEN & SUPPLIES
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.

CARS, SHUTTLE
Goodman Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.

CARS, SHUTTLE, CRAWLER-TYPE
Myers-Whaley Co.—"WHALEY TRANSFER CAR"

CARS, SHUTTLE, DIESEL
Joy Mfg. Co.

CARS, SURGE
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.

CARTRIDGES, CYLINDRICAL AND FLANGE, BALL-BEARING
Bearings, Inc.
Complete Reading Electric Co.

CASTINGS, ABRASION-RESISTANT
Wall Colmonoy Corp.

CASTINGS, HEAT-, CORROSION- & ABRASION-RESISTANT
Electric Steel Foundry Co.

CASTINGS, STEEL
Falk Corp.—"MOLY-TELASTIC"

CAUSTIC SODA
American Minechem Co.
Columbia-Southern Chemical Corp.
The Dow Chemical Co.
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CEMENT, HIGH-TEMPERATURE
Babcock & Wilcox Co.
Philip Carey Mfg. Co.
Joseph Dixon Crucible Co.
Johns-Manville
Mexico Refractories Co.
Norton Co.

CHAIN, CONVEYOR & ELEVATOR
American Brake Shoe Co., Amsco Div.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Chain Belt Co.
Diamond Chain Co., Inc.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
L. B. Foster Co.
Herold Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Link-Belt Co.—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Ore Reclamation Co.
K. Prins & Associates
Republic Steel Corp.—"REPUBLIC"
W. J. Savage Co.
Taylor-Wharton Co. Div.
Transall, Inc.
Watt Car & Wheel Co.
Webster Mfg. Co.
Whitney Chain Co.
Wilmot Engineering Co.

CHAIN POWER-TRANSMISSION
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Browning Mfg. Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Cooke-Wilson Electric Supply Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Morse Chain Co., A Borg-Warner Industry
Transall, Inc.
Whitney Chain Co.

CHAIN, WELDED
American Chain & Cable Co., Inc.
Page Engineering Co.
Pittsburgh Knife & Forge Co.
Republic Steel Corp.

CHAIN FITTINGS
American Chain & Cable Co., Inc.
American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Page Engineering Co.
Pittsburgh Knife & Forge Co.
Republic Steel Corp.—"REPUBLIC"
Taylor-Wharton Co. Div., Harco Corp.

CHAIRS, CAGE-LANDING
Nolan Co.

CHUTES
Barber-Greene Co.
American Brake Shoe Co., Amsco Div.
Bartlett, C. O., & Snow Co.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
Lippman Engrg. Works
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
Pioneer Engineering Works
K. Prins & Associates
Remaly Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Thomas Engineering & Construction Co.
Transall, Inc.
Wilmot Engineering Co.

CHUTES, DIVERSION, COAL LOADING
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Schroeder Bros.
Thomas Engineering & Construction Co.
Transall, Inc.
Wilmot Engineering Co.

CIRCUIT BREAKERS, AIR
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"RUPTAIR"
Crouse-Hinds Co.
Dooley Brothers
Electric Controller & Mfg. Co., Div., Square D Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Genearl Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Heinemann Elec. Co. — "MAGNETTE," "AERO-MAGNETTE," "RE-CIRK-IT," "RE-CIRK-IT-MAGNETTE"
Jeffrey Mfg. Co.
Joy Mfg. Co.
National Mine Service Co.
Square D Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, OIL
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Electric Controller & Mfg. Co., Div., Square D Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
West Virginia Electric Corp.
Westinghouse Electric Corp.

CIRCUIT INTERRUPTORS, TRAILING CABLE
Joy Mfg. Co.
Ohio Brass Co.—"MAGNA-TRIP"

CLAMPS, FUSE & TEST

Bussmann Mfg. Co.—"BUSS"
General Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

CLAMSHELLS

Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Blaw-Knox Co.
Electric Steel Foundry Co.
L. B. Foster Co.
Harnischfeger Corp.
Koehring Co.
Marion Power Shovel Co.—"LORAIN"
Thew Shovel Co.
Unit Crane & Shovel Corp.
Wellman Engineering Co.

CLARIFIERS, EFFLUENT, WASTE WATER

Bulkley, Dunton Processes, Inc.

CLASSIFIERS, HYDRAULIC

Bird Machine Co.
Nelson L. Davis Co.
Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Peterson Filters & Engineering Co.—"CYE"
Smith Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"HYDROTATOR"
Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

CLASSIFIERS, MECHANICAL

Colorado Iron Works—"AKINS"
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Eagle Iron Works
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
Morse Bros. Machinery Co.
Straub Mfg. Co., Inc.
Western Machinery Co.—"WEMCO"

CLUTCH FACINGS

S. K. Wellman Co.

CLUTCHES, AIR

Dodge Mfg. Corp.—"AIR-GRIP"

CLUTCHES, ELECTRIC

I-T-E Circuit Breaker Co.

CLUTCHES, AUTOMATIC

Centric Clutch Co.
Hewitt-Robins, Inc.
Marland One-Way Clutch Co.
Twin Disc Clutch Co.

CLUTCHES, FRICTION

Centric Clutch Co.
Dodge Mfg. Corp.—"DIAMOND D"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
Morse Chain Co., A Borg-Warner Industry—"TORQUE LIMITERS"
Transall, Inc.
Twin Disc Clutch Co.

CLUTCHES, HYDRAULIC

American Blower Corp.
Link-Belt Co.

CLUTCHES, MAGNETIC

Cutler-Hammer, Inc.
Dynamic Div., Eaton Mfg. Co.
Stearns Magnetic, Inc.

CLUTCHES, OVERRUNNING

Centric Clutch Co.
Marland One-Way Clutch Co.
Morse Chain Co., A Borg-Warner Industry—"CAM CLUTCHES"
Joy Mfg. Co.

CLEANERS, STEAM

Homestead Valve Mfg. Co.
Mine Safety Appliances Co.

CLEANING COMPOUNDS, STEAM CLEANING

Homestead Valve Mfg. Co.

COAL ANALYSIS LABORATORIES

Commercial Testing & Engineering Co.
Robert Holmes & Bros., Inc.
Manu-Mine Research & Development Co.
Warner Laboratories

COAL BREAKERS, AIR

Cardox Corp.
Le Roi Div., Westinghouse Air Brake Co.—"ARMSTRONG"
Olin-Mathieson Chemical Corp., Explosives Div
Pennsylvania Crusher Div., Bath Iron Works Corp.

COAL BREAKERS, CO_2

Cardox Corp.

COAL BREAKERS, CHEMICAL

Cardox Corp.

COATINGS, MINE ROOF, RIBS

American Minechem Co.—"ROOFSKIN"
Stonhard Co.

COATINGS, PERMANENT STOPPINGS

American Minechem Co. — "STOPPER-SKIN"
Stonhard Co.

COATINGS, CAST PIPE

Goodyear Tire & Rubber Co., Industrial Prods. Div.
Stonhard Co.

COATINGS, LIQUID STAINLESS-STEEL

Slip-On, Inc.

COATINGS, PROTECTIVE, RUST-PREVENTIVE

American Minechem Co.
Ashland Oil & Refining Co.—"VOTVO-TINE"
Philip Carey Mfg. Co.
Cities Service Oil Co.
Joseph Dixon Crucible Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standard Oil Co.—"RUSTBAN"
Insul-Mastic Corp. of America—"VAPOR-SEAL"
Johns-Manville—"INSULKOTE"
Keystone Lubricating Co.
Magic Chemical Co.—"MAGIC-VULC"
Master Bronze Powder Co.—"DERUSTO"
Minnesota Mining & Mfg. Co.—"SCOTCH-RAP"
Osmose Wood Preserving Co.
Pittsburgh Plate Glass Co. — "PITTS-BURGH"
Ruberoid Co.
Rust-Oleum Corp.
Shell Oil Co.
Sika Chemical Corp.—"SIKASEAL"
Socony Mobil Oil Co.—"SONACOATS"
Stonhard Co.—"STONCOTE"
United States Rubber Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.
Warren Refining & Chemical Co.—"WAR-CO"
Wilbur & Williams Co.

COATINGS, BUILDING ROOFS

Philip Carey Mfg. Co.
Johns-Manville—"ASBESTILE"
Pittsburgh Plate Glass Co. — "PITTS-BURGH"
Ruberoid Co.
Stonhard Co.
Warren Refining & Chemical Co.—"STORM KING," "STORM KING PLUS"

COATINGS, R. R.-CAR

American Minechem Co. — "HOPPER-COAT"

COATINGS, REFRACTORY

Mexico Refractories Co.

COATINGS, WATER SEALING

Philip Carey Mfg. Co.
Insul-Mastic Corp. of America—"VAPOR-SEAL"
Johns-Manville—"INSULKOTE"
Manu-Mine Research & Development Co.
Osmose Wood Preserving Co.
Rust-Oleum Corp.
Sika Chemical Corp.
Stonhard Co.—"STONTITE"
Wilbur & Williams Co.

COIL TESTERS

Complete Reading Electric Co.
Flood City Brass & Electric Co.
Martindale Electric Co.

COILS, ARMATURE, FIELD, ETC.

Complete Reading Electric Co.
Cooke-Wilson Electric Supply Co.
Flood City Brass & Electric Co.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co.
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
West Virginia Armature Co.
Westinghouse Electric Corp.

COILS, DEMAGNETIZING

Dings Magnetic Separator Co.

COLLIMATORS, VERTICAL

Kern Instruments, Inc.

COMMUNICATIONS, CARRIER-CURRENT

Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
Femco, Inc.—"TROLLEYPHONE," "ADO-LINE," "CAGEPHONE"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co. — "MINE-PHONE," "HOISTPHONE"
Talk-A-Phone
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.

COMMUNICATORS, INTEROFFICE & PLANT

Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
Femco, Inc.—"TROLLEYPHONE," "ADO-LINE," "CAGEPHONE"
Graybar Elec. Co., Inc.
Motorola Communications & Electronics, Inc.
Talk-A-Phone
Wheeler Insulated Wire Co., Inc., Div. Sperry Rand Corp.

COMMUTATOR TOOLS

Complete Reading Electric Co.
Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Ohio Carbon Co.
Snap-on Tools Corp.
West Virginia Armature Co.

COMMUTATORS

Complete Reading Electric Co.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
West Virginia Armature Co.

COMPOUNDS, COAL-TREATING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.

Shell Oil Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, DEGREASING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Johns-Manville—"HY-SORB"
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, GENERAL CLEANING

American Minechem Co.
Martindale Electric Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, PIPE-JOINT

Samuel Cabot, Inc.—"PLASGON"
Philip Carey Mfg. Co.—"SEWERITE"
Bowser, Inc.
Joseph Dixon Crucible Co.
Esso Standard Oil Co.
Garlock Packing Co.
Jet-Lube, Inc.—"KOPR-KOTE," "THICK OR THIN"
Keystone Lubricating Co.—"VIKE GRAPHITE PLASTIC COILS," "VIKE WATER-SEAL"
Sika Chemical Corp.—"IGAS"

COMPOUNDS, SPRAY-WATER ADDITIVE

American Minechem Co.
The Dow Chemical Co. — "SEPARAN 2610®"
Johnson-March Corp.—"COMPOUND MR"

CONCRETE FLOOR HARDENERS

Stonhard Co.—"STONTOP"

CONCRETE MIXERS

Koehring Co.

CONCRETE SPRAYING

Cement Gun Co., Inc.—"GUNITE"
Gunite Concrete & Construction Co.
Manu-Mine Research & Development Co.

CONCRETE-SPRAYING EQUIPMENT

Cement Gun Co., Inc.—"CEMENT GUNS"
Manu-Mine Research & Development Co.

CONDUIT, ELECTRICAL

Flexaust Co.—"PLICA"
General Electric Co., Construction Materials Dept.
General Electric Co., Distribution Assemblies Dept.
Graybar Elec. Co., Inc.
Johns-Manville — "TRANSITE," "KOR-DUCT"
Mosebach Electric & Supply Co.
National Electric Products Co.
Republic Steel Corp.—"ELECTRUNITE"
Rome Cable Corp.
Triangle Conduit & Cable Co.
Youngstown Sheet & Tube Co.—"BUCKEYE"

CONDUIT, ELECTRICAL, ALUMINUM

Reynolds Metals Co.

CONDUIT FITTINGS

Crouse-Hinds Co.—"CONDULET"
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
National Electric Products Co.
Rome Cable Corp.
Speer Carbon Co.
Triangle Conduit & Cable Co.
Westinghouse Electric Corp.
Youngstown Sheet & Tube Co.

CONNECTORS, WIRE

American Cyanamid Co., Explosives Dept.
Burndy Engrg. Co., Inc.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
General Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
Hercules Powder Co.
Holub Industries, Inc.
Ideal Industries, Inc.—"WIRENUTS"
Lincoln Electric Co.—"Q-D"
National Electric Products Co.
R. W. Nichols Co.—"DEUTSCH"
Ohio Brass Co.

CONTACTORS, ELECTRICAL

Allen-Bradley Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Complete Reading Electric Co.
Cutler-Hammer, Inc.
Dooley Brothers
Electric Controller & Mfg. Co., Div. Square D Co.—"LINE-ARC"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Carbon Co.
Schroeder Bros.
Square D Co.
Bertrand P. Tracy Co.
Westinghouse Electric Corp.

CONTAINERS, RUBBER COLLAPSIBLE

United States Rubber Co.

CONTINUOUS MINERS

Clarkson Mfg. Co.—"MARIETTA"
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.—"LEE NORSE"
Wilcox Mfg. Co.—"WILCOX CONTIN-COAG MINER"

CONTRACTORS, BUILDING, ERECTING

Arrowhead Steel Buildings, Inc.
Dravo Corp.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Thomas Engineering & Construction Co.
Vincennes Steel Corp.

CONTRACTORS, DRILLING

Drillmaster Supply Co.
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
E. J. Longyear Co.
Manu-Mine Research & Development Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, ELECTRICAL-CONSTRUCTION

The Daniels Co., Contractors, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
West Virginia Electric Corp.

CONTRACTORS, GROUTING

Cowin & Co., Inc.
E. J. Longyear Co.
Manu-Mine Research & Development Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, SHAFT-DRILLING

Cowin & Co., Inc.
Pennsylvania Drilling Co.

CONTRACTORS, SHAFT & SLOPE

Cowin & Co., Inc.
R. G. Johnson Co.
Manu-Mine Research & Development Co.

CONTROLLERS, ELECTRIC, & PARTS

Allen-Bradley Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Bristol Co.—"BRISTOLS"
Clark Controller Co.
Complete Reading Electric Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div., Square D Co.
Ensign Electric & Mfg. Co.
Fischer & Porter Co.
Flood City Brass & Electric Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Harnischfeger Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Schroeder Bros.
Square D Co.
Bertrand P. Tracy Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

CONTROLLERS, ELECTRIC TRACK-SWITCH & DERAIL

Cheatham Elec. Switching Device Co.

CONTROLLERS, ELECTRONIC

The Bristol Co. — "FREE-VANE BRISTOLS"
A. W. Cash Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div., Square D. Co.
Femco, Inc.
Fischer & Porter Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Harnischfeger Corp.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division—"ELECTR-O-PULSE," "ELECTR-O-LINE," "ELECTR-O-VANE"
Reliance Elec. & Eng. Co.
Square D Co.

CONTROLLERS, HYDRAULIC

The Bristol Co.
Joy Mfg. Co.
Schroeder Bros.
Vickers Inc., Div. Sperry Rand Corp.

CONTROLLERS, LOCOMOTIVE

American Brake Shoe Co., Brake Shoe & Castings Div.
General Electric Co., Apparatus Sales Div.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.

CONTROLLERS, PNEUMATIC

B-I-F Industries, Inc.
Black, Sivalls & Bryson, Inc.
The Bristol Co.—"FREEVANE"
A. W. Cash Co.
Farris Flexible Valve Corp. — "FLEX-VALVE"
Fischer & Porter Co.
Foxboro Co.
Joy Mfg. Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co., Industrial Division—"AIR-O-LINE"

CONTROLLERS, TEMPERATURE

West Instrument Corp.—"GUARDSMEN"

CONTROLS, INDUCTIVE-CARRIER, REMOTE

The Bristol Co.—"METAMETER TELEMETER"
Femco, Inc.
Graybar Elec. Co., Inc.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.

CONVEYOR-BELT DRIVE PULLEYS

The American Pulley Co.
Baughman Mfg. Co., Inc.

Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"TAPERLOCK"
Goodman Mfg. Co.
Hewitt-Robins, Inc.
Homer Mfg. Co., Inc.—"HOMER MAGNETIC"
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Transall, Inc.
Webster Mfg. Co.
W. Va. Belt & Cable Repairs, Inc.
T. B. Woods Sons Co.

CONVEYOR-BELT IDLER PULLEYS

The American Pulley Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"TAPERLOCK"
Galigher Co.
Goodman Mfg. Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Transall, Inc
Webster Mfg. Co.
T. B. Woods Sons Co.

CONVEYOR-BELT IDLERS

Barber-Greene Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Galigher Co.
Goodman Mfg. Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"LIMBEROLLER"
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Pettibone Mulliken Co.
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co. — "AUTO-TILT," "MAMMOTH," "SIMPLEX," "SACON," "SUPER SIMPLEX," "JUNIOR SIMPLEX," "PACIFIC"
Transall, Inc.
Webster Mfg. Co.

CONVEYOR-BELT LOADING STATIONS, AUTOMATIC MINE

W. R. Stamler Corp.

CONVEYOR-BELT REPAIR KITS

Magic Chemical Co.

CONVEYOR-BELT TRIPPERS

Bartlett, C. O., & Snow Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
L. B. Foster Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.
Stephens-Adamson Mfg Co.
Transall, Inc.
Webster Mfg. Co.

CONVEYOR-BELT IDLERS, PNEUMATIC

Goodyear Tire & Rubber Co.

CONVEYOR BELTING

Barber-Greene Co.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Cincinnati Rubber Mfg. Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Continental Gin Co., Industrial Div.
L. B. Foster Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"KING KOAL"
Hewitt-Robins, Inc.—"AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE"
Iowa Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Kanawha Mfg. Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTABLE," "CLIFTON," "NYTEX NYLON," "PARA LIFT"
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc. —"QUAKER," "QUAKER PIONEER"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"RECORD-MAKER"
W. J. Savage Co.
Scandinavia Belting Co.
Smith Engineering Works
Thermoid Co., Industrial Div.
Transall, Inc.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.

CONVEYOR-BELTING CLEANERS

Barber-Greene Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Goodrich Co., B. F., Industrial Products Div.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering Works
Stephens-Adamson Mfg Co.
Transall, Inc.
United States Rubber Co.

CONVEYOR-BELTING FASTENERS

Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
Bonded Scale & Machine Co.
Carlyle Rubber Co., Inc.
Continental Gin Co., Industrial Div.
Crescent Belt Fastener Co.
Flexible Steel Lacing Co.
General Splice Corp.—"MINET"
Goodman Mfg. Co.
Gooodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
National Mine Service Co.
Pioneer Engineering Works
Talcott, Inc.
Transall, Inc.
United States Rubber Co.

CONVEYOR-BELTING REPAIR

Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
Carlyle Rubber Co., Inc.
Flexible Steel Lacing Co.
General Splice Corp.
B. F. Goodrich Industrial Products Co.
Industrial Rubber Products Co.
Linatex Corp. of America
Quaker Rubber Div., H. K. Porter Co., Inc.
Reid Belt & Rubber Co.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.

CONVEYOR-BELTING SPLICING MATERIALS

Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
B. F. Goodrich Industrial Products Co.
General Splice Corp.—"MINET"
Goodyear Tire & Rubber Co.
Joy Mfg. Co.
New York Belting & Packing Co.—"N Y B & P"
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR-BELTING VULCANIZERS

B. F. Goodrich Industrial Products Co.
Heintz Mfg. Co.
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR COVERS

Armco Drainage & Metal Prod., Inc.
Arrowhead Steel Buildings, Inc.
Barber-Greene Co.
Continental Gin Co., Industrial Div.
Kanawha Mfg. Co.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Pioneer Engineering Works
Quaker Rubber Div., H. K. Porter Co., Inc.
Transall, Inc.

CONVEYOR LOADING CHECKS

Daly Ticket Co.—"DALY'S"
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR WEIGHERS

B-I-F Industries, Inc.—"CONVEYFLO"
Continental Gin Co., Industrial Div.
Femco, Inc.
Merrick Scale Mfg. Co.—"WEIGHTOMETER"
Transall, Inc.

CONVEYORS, APRON

Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
B. F. Goodrich Industrial Products Co.
Gruendler Crusher & Pulverizer Co.
Herold Mfg. Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates

Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AMSCO"
Transall, Inc.
Webster Mfg. Co.

CONVEYORS, BELT

American Conveyor Co.—"CON-VAY-IT"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Bonded Scale & Machine Co.—"BONDED"
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Chain Belt Co.
J. D. Christian Engineers
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Compton, Inc.
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
L. B. Foster Co.
Goodman Mfg. Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Gruendler Crusher & Pulverizer Co.
Hamilton Rubber Mfg. Corp. — "KING KOAL"
Herold Mfg. Co.
Hewitt-Robins, Inc.—"AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAY-NILE"
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Homer Mfg. Co., Inc.—"HOMER"
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"LIMBEROPE"
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
Meckum Engr. Co.
Morse Bros. Machinery Co.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTIBLE," "CLIF-TON," "NYBTEX NYLON," "PARA LIFT"
Ore Reclamation Co.
Pettibone Mulliken Co.
Pioneer Engineering Works
K. Prins & Associates
Quaker Rubber Div., H. K. Porter Co., Inc.
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"ZIPPER"
Thor Power Tool Co.
Transall, Inc.
United States Rubber Co.
Universal Engineering Co.
Universal Road Machinery Co.
Webster Mfg. Co.

CONVEYORS, BELT, EXTENSIBLE

J. D. Christian Engineers
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.—"MINE-AVEYORS"
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
E. F. Marsh Engrg. Co.
Minnesota Mining & Mfg. Co.—"SCOTCH-LOKS"
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

CONVEYORS, BUCKET

American Brake Shoe Co., Amsco Div.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Fairmont Machinery Co.
L. B. Foster Co.
Galigher Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Koehring Co.
Link-Belt Co.
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Ridge Equipment Co.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Co.
Wilmot Engineering Co.

CONVEYORS, CHAIN, CHAIN & FLIGHT

American Brake Shoe Co., Amsco Div.
American Brake Shoe Co., Electro-Alloys Div.
American Conveyor Co. — "FLIGHT-VEYOR"
American Well Works
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Clarkson Mfg. Co.—"REDBIRD," "UNI-FLIGHT"
Compton, Inc.
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Electric Steel Foundry Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Herold Mfg. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
The Long Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
K. Prins & Associates
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Vulcan Iron Works
Watt Car & Wheel Co.
Webster Mfg. Co.
Wilmot Engineering Co.

CONVEYORS, ELEVATING

Bartlett, C. O., & Snow Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Koehring Co.
Link-Belt Co.
Lippmann Engrg. Works
The Long Co.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co. — "REDLER ZIPPER"
Transall, Inc.
United States Rubber Co.
Webster Mfg. Co.
Wilmot Engineering Co.

CONVEYORS, ELEVATING, MINE TRANSFER, CAR LOADING

Bonded Scale & Machine Co.
J. D. Christian Engineers
Fairmont Machinery Co.
Goodman Mfg. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.

CONVEYORS, MAGNETIC

Homer Mfg. Co., Inc.—"HOMER"

CONVEYORS, MINE BRIDGE

Goodman Mfg. Co.
Robert Holmes & Bros., Inc.
Link-Belt Co.
The Long Co.—"PIGGYBACK"
E. F. Marsh Engrg. Co.
Transall, Inc.

CONVEYORS, OSCILLATING

Link-Belt Co.—"LINK-BELT"

CONVEYORS, PNEUMATIC

Convair
U. S. Hoffman Machinery Corp., Industrial Div.

CONVEYORS, PORTABLE

American Conveyor Co.—"CON-VAY-IT"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Barber-Greene Co.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Bonded Scale & Machine Co.—"BONDED"
J. D. Christian Engineers
L. B. Foster Co.
Goodman Mfg. Co.
George Haiss Mfg. Co., Div., Pettibone Mulliken Corp.
Herold Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pettibone Mulliken Co.
Pioneer Engineering Works
Stephens-Adamson Mfg. Co.

CONVEYORS, ROPE & BUTTON

Fairmont Machinery Co.

Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Transall, Inc.

CONVEYORS, SCREW

Bartlett, C. O., & Snow Co.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Canton Stoker Corp.—"FLO-TUBE"
J. D. Christian Engineers
Colorado Iron Works
Continental Gin Co., Industrial Div.
Dallas Engineers Inc., Coal-O-Matic Div.
Dayton Automatic Stoker Co.
Fairfield Engineering Co.
L. B. Foster Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Co.

CONVEYORS, SELF-LOADING, MINE

Herold Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, SHAKING, MINE

Goodman Mfg. Co.
Herold Mfg. Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
Vulcan Iron Works

CONVEYORS, SHAKING, VIBRATING

Ajax Flexible Coupling Co., Inc.—"AJAX LO-VEYOR"
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Lecco Engrg. & Mfg. Co.—"LECCO VIB"
Link-Belt Co.
Simplicity Engineering Co.—"OS-A-VEY-OR"
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

CONVEYORS, SPIRAL LOWERING

J. D. Christian Engineers
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Quaker Rubber Div., H. K. Porter Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.

COPYING EQUIPMENT

Charles Bruning Co., Inc.

CORDS, DRILL

Collyer Insulated Wire Co.
Cooke-Wilson Electric Supply Co.
Electrical Wire & Cable Dept., United States Rubber Co.
Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Rome Cable Corp.

CORDS, PORTABLE, ELECTRIC

Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Electrical Wire & Cable Dept., United States Rubber Co.—"U. S. LATEX ROYAL MASTER"
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Okonite Co.
John A. Roebling's Sons Co., Div., Colorado Fuel & Iron Co.
Rome Cable Corp.

COUPLERS, AUTOMATIC MINE CAR

C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Mayo Tunnel & Mine Equipment Co.
National Malleable & Steel Castings Co.—"WILLISON," "SHARON"
Ohio Brass Co.
Rydin Railway Equip. Co.

COUPLERS, MINE-CAR

Utility Mine Equipment Co.

COUPLINGS, AIR-LINE

Acme Machinery Co.
Cleco Div., Reed Roller Bit Co.
Hose Accessories Co.
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
Lincoln Engrg. Co.
R. W. Nichols Co.—"BRUNING-CRAFTON"
Schroeder Bros.

COUPLINGS, CHAIN

Dodge Mfg. Corp.—"TAPER-LOCK"

COUPLINGS, CLUTCH

Marland One-Way Clutch Co.

COUPLINGS, FIRE HOSE

Fyr-Fyter Co.

COUPLINGS, FLEXIBLE

Farrel-Birmingham Co., Inc.

COUPLINGS, FLEXIBLE-SHAFT

Ajax Flexible Coupling Co., Inc.
American Flexible Coupling Co.—"AMERICAN-AMERIGEAR"
Browning Mfg. Co.
Chain Belt Co.
Chiksan Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
DeLaval Steam Turbine Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK"
Elliott Co.
Falk Corp.—"STEELFLEX," "AIRFLEX"
James Gear Mfg. Co., D. O.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Koppers Co., Inc., Metal Products Div.—"FAST'S"
Link-Belt Co.
Lovejoy Flexible Coupling Co.
Morse Chain Co., A Borg-Warner Industry—"MORFLEX"
New York Belting & Packing Co.
Philadelphia Gear Works
Thomas Flexible Coupling Co.—"THOMAS"
Webster Mfg. Co.
Whitney Chain Co.
T. B. Woods Sons Co.

COUPLINGS, FLUID & HYDRAULIC LINES

Aeroquip Corp.
Blackhawk Mfg. Co.
Chiksan Co.
Hose Accessories Co.
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
Link-Belt Co.
R. W. Nichols Co.—"BRUNING-CRAFTON"
Walworth Co.
Weatherhead Co., Fort Wayne Div.

COUPLINGS, GROOVED-END PIPE

Gustin-Bacon Mfg. Co.—"GRUVAGRIP," "GRUVAJOINT"

COUPLINGS, HOSE

Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Franklin Plastics Inc.—"DUR X PLASTIC"
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hewitt-Robins, Inc.
Hose Accessories Co.
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
Joy Mfg. Co.—"SURGEPRUF"
Lincoln Engrg. Co.
Meckum Engr. Co.
New York Belting & Packing Co.
R. W. Nichols Co.—"CRAFTON"
Schroeder Bros.
Thor Power Tool Co.
United States Rubber Co.—"EVERTITE"
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

COUPLINGS, HYDRAULIC-DRIVE

Link-Belt Co.
Transall, Inc.
Twin Disc Clutch Co.

COUPLINGS, MAGNETIC-DRIVE

Dynamatic Div., Eaton Mfg. Co.
Transall, Inc.
Victaulic Co. of America

COUPLINGS, SWIVEL, BRONZE

Lunkenheimer Co.

CRANES, CRAWLER

Link-Belt Speeder Corp.

CRANES, MOBILE

American Hoist & Derrick Co.—"AMERICAN"
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.
Clyde Iron Works, Inc.
Dravo Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Hyster Co.—"KARRY KRANE"
Koehring Co.
LeTourneau-Westinghouse Co.—"TOURNA-PULL"
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.
Thew Shovel Co.—"LORAIN"
Transall, Inc.
Unit Crane & Shovel Corp.

CRANES, SHOP & PLANT

Austin-Western Works, Construction Equipment Div.
Bay City Shovels, Inc.
L. B. Foster Co.
Guyan Machy. Co.
Harnischfeger Corp.
Koehring Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"SHAW BOX LOAD LIFTER"
Morse Bros. Machinery Co.
Robbins & Meyers, Inc.—"R & M"
Shepard Niles Crane & Hoist Corp.
Transall, Inc.
Wright Hoist Div., American Chain & Cable Co., Inc.

CRANES, TRACTOR & TRUCK

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Austin-Western Works, Construction Equipment Div.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Clark Equip. Co., Automotive Div. — "MICHIGAN"
Clark Equipment Co., Construction Machinery Div.
Four Wheel Drive Auto Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Marion Power Shovel Co.
Quick-Way Truck Shovel Co.
Yale & Towne Mfg. Co.

CRANES, TRUCK

American Hoist & Derrick Co.—"AMERICAN"
Austin-Western Works, Construction Equipment Div.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Automotive Div.—"MICHIGAN"
Clark Equipment Co., Construction Machinery Div.
Four Wheel Drive Auto Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Henrickson Mfg. Co.
Insley Mfg. Corp.
Koehring Co.
Link-Belt Speeder Corp. — "ZEPHYR-CRANES"
Marion Power Shovel Co.
Northwest Engineering Co.
Pitman Manufacturing Co. — "HYDRO-LIFT"
Quick-Way Truck Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.
Thew Shovel Co. — "LORAIN MOTO-CRANE"
Yale & Towne Mfg. Co.

CRAWLER PADS

American Brake Shoe Co., Amsco Div.

CROSSING SIGNALS, RAIL, HIGHWAY

American Mine Door Co.
Nachod & U. S. Signal Co.

CRUSHER JAWS

American Brake Shoe Co., Amsco Div.

CRUSHERS, HAMMER

American Pulverizer Co.
Bartlett, C. O., & Snow Co.
Crusher Engineering Div., Poor & Co.
L. B. Foster Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pettibone Mulliken Co.
Sprout, Waldron & Co., Inc.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Transall, Inc.
Universal Engineering Co.—"BULLDOG"
Williams Patent Crusher & Pulv. Co.

CRUSHERS, IMPACT

Hazemag—MBH

CRUSHERS, JAW

Denver Equipment Co.—"DENVER"
Universal Engineering Co.—"BULLDOG"

CRUSHERS, LABORATORY

American Pulverizer Co.
Central Scientific Co.
Crusher Engineering Div., Poor & Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv. Co.
Wise Co., O. B.

CRUSHERS, REPLACEMENT PARTS

American Brake Shoe Co., Amsco Div.
American Steel Foundries—"WEARPACT"
Crusher Engineering Div., Poor & Co.
Electric Steel Foundry Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering Works
Stedman Foundry & Machine Co., Inc.
Taylor-Wharton Co. Div.
The Tool Steel Gear & Pinion Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, RING

American Pulverizer Co.
Crusher Engineering Div., Poor & Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Simplicity Engineering Co.
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.—"KNITTEL"
Transall, Inc.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, ROLL

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Crusher Engineering Div., Poor & Co.
Denver Equipment Co.—"DENVER"
Eagle Iron Works
L. B. Foster Co.
Gruendler Crusher & Pulverizer Co.
Guyan Machy. Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pettibone Mulliken Co.
Pioneer Engineering Works
Ridge Equipment Co.
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webster Mfg. Co.
Williams Patent Crusher & Pulv. Co.
Wilmot Engineering Co.

CRUSHERS, SAMPLE

American Pulverizer Co.
Crusher Engineering Div., Poor & Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, TWO-STAGE

Bartlett, C. O., & Snow Co.
Crusher Engineering Div., Poor & Co.
Gruendler Crusher & Pulverizer Co.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc.—"GUNDLACH"
Kennedy-Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Universal Engineering Co.—"TWINDUAL"
Williams Patent Crusher & Pulv. Co.

CULVERTS, CORRUGATED-METAL

Armco Drainage & Metal Prod., Inc.

CUPS, GREASE AND OIL

Lunkenheimer Co.

CUT-OUTS-ELECTRICAL

The Bryant Electric Co.
Duquesne Mine Supply Co.
Electric Controller & Mfg. Co., Div., Square D Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.

CUTTER BARS

Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Frank Prox Co., Inc.
Bertrand P. Tracy Co.

CUTTER BITS, CARBON-STEEL

Bowdil Co.
Crucible Steel Co. of America
Cutter Bit Service Co.—"CUTRITE"
Goodman Mfg. Co.
Howells Mining Drill Co.
Joy Mfg. Co.
Leetonia Tool Co.
Marathon Coal Bit Co.
Pittsburgh Knife & Forge Co.
Salem Tool Co.

CUTTER BITS, ALLOY-STEEL

Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Crucible Steel Co. of America—"REX," "REXALLOY"
Cutter Bit Service Co.—"CUTRITE"
Goodman Mfg. Co.
H. & L. Tooth Co.
Marathon Coal Bit Co.
Penn Machine Co.
Frank Prox Co., Inc.
Salem Tool Co.

CUTTER BITS, HARD-SURFACED, PLATED, TIPPED

Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Crucible Steel Co. of America
Cutter Bit Service Co.—"CUTRITE"
Firth Sterling, Inc.—"FIRTHITE"
Goodman Mfg. Co.
Penn Machine Co.

Frank Prox Co., Inc.
Salem Tool Co.

CUTTER BITS, CARBIDE-INSERT-TIPPED

Allegheny Ludlum Steel Corp.
Bowdil Co.
Carboloy Dept., General Electric Co.
Cincinnati Mine Machinery Co.—"CINIDE"
Cutter Bit Service Co.—"CUTRITE"
Firth Sterling, Inc.—"FIRTHITE"
Guyan Machy. Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Kennametal, Inc.
Marathon Coal Bit Co.
Metal Carbides Corp.
National Mine Service Co.
Newcomer Products, Inc.
Penn Machine Co.
Frank Prox Co., Inc.
Salem Tool Co.
W. J. Savage Co.—"CARBOLOY"
Vascoloy-Ramet Corp.

CUTTER BITS, THROWAWAY

Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"DUPLEX," "STANEX"
Goodman Mfg. Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Marathon Coal Bit Co.
National Mine Service Co.
Penn Machine Co.
Frank Prox Co., Inc.—"TOOL STEEL," "DUO"
Salem Tool Co.
W. J. Savage Co.

CUTTER CHAINS

Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Marathon Coal Bit Co.
Penn Machine Co.
Frank Prox Co., Inc.
Bertrand P. Tracy Co.

CUTTERS, BAR, CABLE, CHAIN, ROD, WIRE ROPE, ETC.

H. K. Porter, Inc.

CUTTERS, PIPE

Beaver Pipe Tools, Inc.

CUTTING MACHINES

L. B. Foster Co.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.

CUTTING TORCHES—See Welding Torches

CUTTINGS MACHINES, CONVERTED TRACK TO RUBBER

Jeffrey Mfg. Co.
Lee-Norse Co.

CYCLONES, AIR TREATMENT

Bartlett, C. O., & Snow Co.
Combustion Engineering, Inc., Raymond Div.
The Daniels Co. Contractors, Inc.
Ducon Co.
Hardinge Co., Inc.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Mechanical Industries, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Precipitation Corp. — "MULTI-CLONE"

CYCLONES, WATER TREATMENT

Bird Machine Co.
Centrifugal & Mech. Industries, Inc. — "CLUST-R-CLONE"
The Daniels Co. Contractors, Inc.
Dorr-Oliver, Inc.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
Peterson Filters & Engineering Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CYLINDERS, AIR

Ledeen Mfg. Co.
R. W. Nichols Co.—"ALKEN"
Wellman Engineering Co., McDowell Enterprise

CYLINDERS, DOOR OPERATORS

Ledeen Mfg. Co.

DERAILERS

American Mine Door Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Miners' Hardware Supply Co.
The Nolan Co.
Sanford Day Iron Works, Inc.

DERAILERS, ELECTRIC, AUTOMATIC & REMOTELY CONTROLLED

American Mine Door Co.
Cheatham Elec. Switching Device Co.

DERRICKS

American Hoist & Derrick Co.

DETECTORS, TRAMP-IRON

Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Stearns Magnetic, Inc.

DETERGENT, GERMICIDAL

American Minechem Co.

DETONATOR BOXES, WOOD

King Powder Co., Inc.
Mine Safety Appliances Co.

DETONATORS, ELECTRIC

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.

DETONATORS, MILLISECOND-DELAY

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
King Powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.

DETONATORS, SHORT DELAY

American Cyanamid Co., Explosives Dept.—"AMERICAN"
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.

DETONATORS, STANDARD-DELAY

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.

DIAMONDS, INDUSTRIAL

Hoffman Brothers Drilling Co.
E. J. Longyear Co.
J. K. Smit & Sons
Sprague & Henwood

DIAPHRAGMS, PUMPS, VALVES, ETC.

United States Rubber Co.

DIPPER TEETH, BASES, INSERTS, ETC.

American Brake Shoe Co., Amsco Div.
American Steel Foundries—"WEARPACT"
Electric Steel Foundry Co.
H. & L. Tooth Co.
Kensington Steel Co.
Koehring Co.
Marion Power Shovel Co.
Taylor-Wharton Co. Div., Harsco Corp.

DIPPERS, SHOVEL

American Brake Shoe Co., Amsco Div.
Electric Steel Foundry Co.
Marion Power Shovel Co.
Pettibone Mulliken Co.

DISCS, RUPTURE

Black, Sivalls & Bryson, Inc.

DISTRIBUTION BOXES, ELECTRICAL, STRIPPING

Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Westinghouse Electric Corp.

DISTRIBUTION BOXES, ELECTRICAL, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD," "GROUND-GUARD"
The Elreco Corp.—"ELRECO"
Ensign Electric & Mfg. Co.
G & W Electric Specialty Co.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.
Schroeder Bros.
Westinghouse Electric Corp.

DISTRIBUTORS, HYDRAULIC COAL FEED

Deister Machine Co.
Denver Equipment Co.—"DENVER"
Heyl & Patterson, Inc.

DOORS, AIR-POWERED

American Mine Door Co.

DOORS, FURNACE-OBSERVATION, ACCESS

Bigelow-Liptak Corp.

DOORS, INDUSTRIAL STEEL

Steelcraft Mfg. Co.

DOORS, QUICK OPENING

Dravo Corp.

DOORS, MINE

American Mine Door Co.
Clarkson Mfg. Co.—"CLARKSON"

DOORS, MINE, AUTOMATIC

American Mine Door Co.

DRAFT GEAR, RUBBER

Enterprise Wheel & Car Corp.
National Malleable & Steel Castings Co.—"NATIONAL MULTI-PAD"

DRAFTING EQUIPMENT, SUPPLIES

Charles Bruning Co., Inc.
Dietzgen Co., Inc., Eugene
Geo-Optic Co., Inc.
Keuffel & Esser Co.
Wild Heerbrugg Instruments, Inc.

DRAGLINES, CRAWLER

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.

Clark Equipment Co., Construction Machinery Div.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Nortrwest Engineering Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, RUBBER-TIRED

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, WALKING

Bucyrus-Erie Co.
Marion Power Shovel Co.
Page Engineering Co.

DRIERS, CENTRIFUGAL

Bird Machine Co.
Blaw-Knox Co.
Centrifugal & Mech. Industries, Inc.
Dorr-Oliver, Inc.
Heyl & Patterson, Inc.—"REINEVELD"
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co.

DRIERS, CENTRIFUGAL, SCREEN TYPE SOLID-BOWL

Bird Machine Co.

DRIERS, FLUIDIZED HED

Dorr-Oliver, Inc.

DRIERS, HEAT

Bartlett, C. O., & Snow Co.
J. D. Christian Engineers
Colorado Iron Works
Combustion Engineering, Inc., Raymond Div.
Nelson L. Davis Co.
Denver Equipment Co.
Dravo Corp.
Hardinge Co., Inc.
Hazemag-MBH
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.
Silver Engineering Works, Inc.
Western Precipitation Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.
Wyssmont Co., Inc.

DRILL AUGERS, COAL

Cardox Corp.
Central Mine Equipment Co.
Compton, Inc.
Dooley Brothers
Drillmaster Supply Co.
Howells Mining Drill Co.
Kennametal, Inc.
Leetonia Tool Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling Co., Inc.
National Mine Service Co.
Paris Mfg. Co.
Salem Tool Co.
Schroeder Bros.
Taylor-Wharton Co. Div., Harsco Corp.
Thor Power Tool Co.

DRILL AUGERS, STRIP OVERBURDEN

Cardox Corp.
Central Mine Equipment Co.
Drillmaster Supply Co.
Mayheu Supply Co., Inc.
McLaughlin Mfg. Co., Inc.
Mobile Drilling Co., Inc.
Paris Mfg. Co.
Salem Tool Co.

DRILL BITS, COAL

Carboloy Dept., General Electric Co.
Cardox Corp.
Central Mine Equipment Co.
Cleco Div., Reed Roller Bit Co.
Compton, Inc.
Dooley Brothers
Drillmaster Supply Co.
Gibraltar Equipment & Mfg. Co.
Herb J. Hawthorne, Inc.
Hoffman Brothers Drilling Co.
Howells Mining Drill Co.
Marathon Coal Bit Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling Co., Inc.
National Mine Service Co.
Newcomer Products, Inc.
Paris Mfg. Co.
Frank Prox Co., Inc.
Salem Tool Co.
Schroeder Bros.
Stardrill-Keystone Co.

DRILL BITS, COAL, CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.
Brunner & Lay, Inc.
Carboloy Dept., General Electric Co.
Cleco Div., Reed Roller Bit Co.
Drillmaster Supply Co.
Firth Sterling, Inc.—"FIRTHITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Kennametal, Inc.
Marathon Coal Bit Co.
McLaughlin Mfg. Co., Inc.
Metal Carbides Corp.
Newcomer Products, Inc.
Paris Mfg. Co.
Frank Prox Co., Inc.
Salem Tool Co.
W. J. Savage Co.
Schroeder Bros.
Vascoloy-Ramet Corp.

DRILL BITS, CHURN

Spang & Co.
Stardrill-Keystone Co.—"ACME"

DRILL BITS, CORE

Acker Drill Co.
Drillmaster Supply Co.
George E. Failing Co.
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
Kennametal, Inc.
E. J. Longyear Co.
Mayheu Supply Co., Inc.
Mobile Drilling Co., Inc.
Mott Core Drilling Co.
Newcomer Products, Inc.
Pennsylvania Drilling Co.
Sprague & Henwood
Varel Mfg. Co., Inc.

DRILL BITS, DIAMOND

Acker Drill Co.
Drillmaster Supply Co.
George E. Failing Co.
Joy Mfg. Co.
E. J. Longyear Co.
Metal Carbides Corp.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
J. K. Smit & Sons—"HARD HED"
Sprague & Henwood
Varel Mfg. Co., Inc.

DRILL BITS, DIAMOND, RESETTING SERVICE

Sprague & Henwood

DRILL BITS, MOLEFOOT, STRIPPING

Cardox Corp.
Central Mine Equipment Co.
Drillmaster Supply Co.
Marathon Coal Bit Co.
Mobile Drilling Co., Inc.
Paris Mfg. Co.
Salem Tool Co.

DRILL BITS, PERCUSSION

Acme Machinery Co.
Brunner & Lay, Inc.
Bucyrus-Erie Co.
Drillmaster Supply Co.
Gardner-Denver Company
Guyan Machy. Co.—"THROW-AWAY"
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mobile Drilling Co., Inc.
Schroeder Bros.
Stardrill-Keystone Co.—"ACME"
Thor Power Tool Co.
Throwaway Bit Corp.

DRILL BITS, PERCUSSION, CARBIDE-TIPPED

Acme Machinery Co.
Allegheny Ludlum Steel Corp.
Brunner & Lay, Inc.—"ROK-BITS"
Carboloy Dept., General Electric Co.
Drillmaster Supply Co.
Firth Sterling, Inc.—"FIRTHITE"
Joy Mfg. Co.
Ingersoll-Rand Co.
Kennametal, Inc.
Marathon Coal Bit Co.
Metal Carbides Corp.
Newcomer Products, Inc.
Thor Power Tool Co.
The Timken Roller Bearing Co.
Vascoloy-Ramet Corp.

DRILL BITS, ROOF-CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.
Brunner & Lay, Inc.—"INTRA-SET"
Carboloy Dept., General Electric Co.
Drillmaster Supply Co.
Firth Sterling, Inc.—"FIRTHITE"
Guyan Machy. Co.—"FIRTHITE"
Kennametal, Inc.
Marathon Coal Bit Co.
Metal Carbides Corp.
Newcomer Products, Inc.
Frank Prox Co., Inc.
W. J. Savage Co.
Vascoloy-Ramet Corp.

DRILL BITS, ROTARY, DRY, STRIPPING

Carboloy Dept., General Electric Co.
Cardox Corp.
Central Mine Equipment Co.
Davey Compressor Co.
Drillmaster Supply Co.
George E. Failing Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Brothers Drilling Co.
Hughes Tool Co.
Marathon Coal Bit Co.
Mayheu Supply Co., Inc.
Mobile Drilling Co., Inc.
Varel Mfg. Co., Inc.

DRILL BITS, ROTARY, WET, STRIPPING

Carboloy Dept., General Electric Co.
Cardox Corp.
Drillmaster Supply Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Brothers Drilling Co.
Hughes Tool Co.
Marathon Coal Bit Co.
Mayheu Supply Co., Inc.
Mobile Drilling Co., Inc.
Varel Mfg. Co., Inc.

DRILL BITS, ROTARY, WET, CARBIDE-TIPPED, STRIPPING

Allegheny Ludlum Steel Corp.
Carboloy Dept., General Electric Co.
Drillmaster Supply Co.
Firth Sterling, Inc.—"FIRTHITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Marathon Coal Bit Co.
Metal Carbides Corp.
Varel Mfg. Co., Inc.
Vascoloy-Ramet Corp.

DRILL BOXING

Leetonia Tool Co.

DRILL CORE BARRELS

E. J. Longyear Co.

DRILL JUMBOS

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Gibraltar Equipment & Mfg. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mayo Tunnel & Mine Equipment Co.
Schroeder Bros.
Thor Power Tool Co.

DRILL PIPE

Davey Compressor Co.
George E. Failing Co.
L. B. Foster Co.
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
E. J. Longyear Co.
National Supply Company — "SPANG-WELD"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Stardrill-Keystone Co.
Varel Mfg. Co., Inc.

DRILL PRESSES

Farrel-Birmingham Co., Inc.
R. W. Nichols Co.
South Bend Lathe Works

DRILL RODS

E. J. Longyear Co.

DRILL SHARPENERS

Gardner-Denver Company
Ingersoll-Rand Co.
Stardrill-Keystone Co.—"ACME"

DRILL STEEL

Acme Machinery Co.
Bethlehem Steel Co.
Brunner & Lay, Inc.
Crucible Steel Co. of America—"VICTOR CRUCIBLE"
Davey Compressor Co.
Gardner-Denver Company
Gibraltar Equipment & Mfg. Co.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Marathon Coal Bit Co.
Mayheu Supply Co., Inc.
National Mine Service Co.
Joseph T. Ryerson & Son, Inc.
Schroeder Bros.
Thor Power Tool Co.

DRILL STEEL, HOLLOW

Crucible Steel Co. of America

DRILL THREAD BARS

Leetonia Tool Co.

DRILL TOOLS, CHURN

Spang & Company

DRILLS, COAL, FLEXIBLE-SHAFT

Jeffrey Mfg. Co.

DRILLS, COAL, HAND

Dooley Brothers
Ensign Electric & Mfg. Co.
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Leetonia Tool Co.
Mall Tool Co.—"MALL"
Ohio Brass Co.
Penn Machine Co.
Salem Tool Co.
Schroeder Bros.

DRILLS, COAL, HAND-HELD

Chicago Pneumatic Tool Co.—"WHIPPET CP"
Cincinnati Electrical Tool Co.
Dooley Brothers
Ensign Electric & Mfg. Co.
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Penn Machine Co.
Salem Tool Co.
Schroeder Bros.

DRILLS, COAL, HAND-HELD HYDRAULIC

Chicago Pneumatic Tool Co.—"CP"
Ensign Electric & Mfg. Co.
Jeffrey Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Penn Machine Co.
Schroeder Bros.

DRILLS, COAL, MOUNTED SELF-PROPELLED

Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Lee-Norse Co.—"LEE NORSE DRILL TRUCK"
Paris Mfg. Co.
Penn Machine Co.
Salem Tool Co.
Stardrill-Keystone Co.—"SPEED STAR", "KEYSTONE", "FRANKS"
Winter-Weiss Co.

DRILLS, COAL, POST-MOUNTED

Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Leetonia Tool Co.
Morse Bros. Machinery Co.
Penn Machine Co.
Salem Tool Co.

DRILLS, COMPRESSED-AIR

Howells Mining Drill Co.—"HOWELLS"

DRILLS, CORE

Acker Drill Co.
Chicago Pneumatic Tool Co.—"CP"
George E. Failing Co.
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
E. J. Longyear Co.
Mayheu Supply Co., Inc.
Mobile Drilling Co., Inc.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood
Winter-Weiss Co.

DRILLS, ELECTRIC

Howells Mining Drill Co.—"SPRY"

DRILLS, OVERBURDEN, SIDEWALL

Chicago Pneumatic Tool Co.—"CP"
George E. Failing Co.
Joy Mfg. Co.
Mobile Drilling Co., Inc.
Paris Mfg. Co.
Salem Tool Co.

DRILLS, OVERBURDEN, TRACTOR-MOUNTED PNEUMATIC

Chicago Pneumatic Tool Co.—"TRAC-DRIL"
Davey Compressor Co.
Gardner-Denver Company
Joy Mfg. Co.—"CHALLENGER"
Schramm, Inc.
Winter-Weiss Co.

DRILLS, OVERBURDEN, VERTICAL CHURN

Bucyrus-Erie Co.
Mott Core Drilling Co.
Stardrill-Keystone Co.—"SPEED STAR," "KEYSTONE"

DRILLS, OVERBURDEN, VERTICAL ROTARY

Bucyrus-Erie Co.
Cardox Corp.
Davey Compressor Co.
George E. Failing Co.
Joy Mfg. Co.—"CHAMPION"
E. J. Longyear Co.
Mayheu Supply Co., Inc.
Paris Mfg. Co.
Reich Bros. Mfg. Co., Inc.
Salem Tool Co.
Schramm, Inc.
Stardrill-Keystone Co. — "KEYSTONE," "FRANKS"
Winter-Weiss Co.

DRILLS, PNEUMATIC

Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Cleco Div., Reed Roller Bit Co.
Davey Compressor Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co.—"MALL"
Schramm, Inc.
Schroeder Bros.
Thor Power Tool Co.
Worthington Corp.

DRILLS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

DRILLS, PROSPECTING

Hossfeld Mfg. Co.—"HOSSFELD DIRECT DRIVE"

DRILLS, ROOF-BOLTING

Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
J. H. Fletcher & Co.
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Schroeder Bros.
Thor Power Tool Co.

DRILLS, STRIP-COAL, TRACTOR-MOUNTED PNEUMATIC

Cardox Corp.
Chicago Pneumatic Tool Co.—"H-BOOM"
Gardner-Denver Company
Joy Mfg. Co.—"CHALLENGER"
Salem Tool Co.
Schramm, Inc.

DRILLS, STRIP-COAL, VERTICAL ELECTRIC

Cardox Corp.
Joy Mfg. Co.—"CHAMPION"
Mayheu Supply Co., Inc.
Penn Machine Co.
Salem Tool Co.

DRIVES, ADJUSTABLE SPEED

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
American Blower Corp.
The American Pulley Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Link-Belt Co.
Philadelphia Gear Works
Reliance Elec. & Eng. Co.—"RELIANCE V*S"
Transall, Inc.
Vickers, Inc., Div. Sperry Rand Corp.
Worthington Corp.

DRIVES, CHAIN

Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Four Wheel Drive Auto Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
National Supply Company—"IDEAL"
Transall, Inc.
Whitney Chain Co.

DRIVES, EMERGENCY, FANS, ETC.

Philadelphia Gear Works

DRIVES, FLUID

American Blower Corp.
Dodge Mfg. Corp.—"FLEXIDYNE"
Link-Belt Co.
Master Electric Co.
National Supply Company—"IDEAL GYROL"
Transall, Inc.
Twin Disc Clutch Co.

DRIVES, GEAR

The Louis Allis Co.
Baughman Mfg. Co., Inc.
Blaw-Knox Co.
J. D. Christian Engineers
Cleveland Worm & Gear Co.
DeLaval Steam Turbine Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Co.—"GEARMOTOR"
Four Wheel Drive Auto Co.
Hewitt-Robins, Inc.—"JONES"
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Master Electric Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
Transall, Inc.
U. S. Electrical Motors, Inc.—"SYNCHRO-GEAR"

DRIVES, SELECTIVE-SPEED

Century Electric Co.

DRIVES, SHAFT MOUNTED

Falk Corp.

DRIVES, V-BELT

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEXROPE"
The American Pulley Co.
Bonded Scale & Machine Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Dayton Rubber Co.
Dodge Mfg. Corp.
Flood City Brass & Electric Co.
Gates Rubber Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Lovejoy Flexible Coupling Co.
New York Belting & Packing Co.—"GILMER"
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.
Thermoid Co., Industrial Div.
Transall, Inc.
Worthington Corp.

DRIVES, VARIABLE-SPEED

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
The Louis Allis Co.
The American Pulley Co.
Bonded Scale & Machine Co.
J. D. Christian Engineers
Clark Controller Co.
Cleveland Worm & Gear Co.
Dodge Mfg. Corp.
Dynamatic Div., Eaton Mfg. Co.
Foote Brothers Gear & Machinery Corp.—"VARI-MOUNT"
General Electric Co., Apparatus Sales Div.
Hewitt-Robins, Inc.
Kanawha Mfg. Co.
Link-Belt Co.
Lovejoy Flexible Coupling Co.
Master Electric Co.
Philadelphia Gear Works
Reeves Pulley Co.
Reliance Elec. & Eng. Co.—"RELIANCE V*S"
Reliance Electric & Engineering Co., Reeves Pulley Co. Div.
Schroeder Bros.
Stephens-Adamson Mfg. Co.—"JFS"
Transall, Inc.
U. S. Electrical Motors, Inc.—"VARI-DRIVE"
Vickers, Inc., Div. Sperry Rand Corp.
Worthington Corp.

DRIVES, VARIABLE SPEED, HYDRAULIC

American Engineering Co.

DRIVES, VARIABLE-SPEED, EDDY-CURRENT

The Louis Allis Co.
Dynamatic Div., Eaton Mfg. Co.
Hewitt-Robins, Inc.
Kanawha Mfg. Co.

DUCKBILL LOADING HEADS

Goodman Mfg. Co.

DUCT, AIR

Armco Drainage & Metal Prod., Inc.
C. R. Daniels Co.
Flexaust Co.—"FLEXAUST"
Flexible Tubing Co.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

DUCT, BUS, ELECTRICAL

General Electric Co., Distribution Assemblies Dept.
I-T-E Circuit Breaker Co.
National Electric Products Co.
Revere Copper & Brass, Inc.
Square D Co.
Westinghouse Electric Corp.

DUCT, BUS, ELECTRICAL, ALUMINUM

Reynolds Metals Co.

DUCT, CABLE, ELECTRICAL

Delta-Star Electric Div., H. K. Porter Co., Inc.
Flexaust Co.—"PLICA"
National Electric Products Co.
Square D Co.

DUCT, CABLE, ELECTRICAL, ALUMINUM

Reynolds Metals Co.

DUMPS, CROSSOVER, KICKBACK

Bartlett, C. O., & Snow Co.
C. S. Card Iron Works
The Nolan Co.

DUMPS, ROTARY, MINE-CAR

Atlas Car & Mfg. Co.
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wellman Engineering Co., McDowell Enterprise

DUST COLLECTOR TUBES

Bemis Bro. Bag Co.

DUST COLLECTORS

Johnson-March Corp.

DUST COLLECTORS, MECHANICAL, COAL HANDLING, PREPARATION

American Air Filter Co.
American Blower Corp.
Ducon Co.
Fly Ash Arrestor Corp.
Hazemag-MBH
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Koppers Co., Inc., Metal Products Div.
R. C. Mahon Co.
Majac, Inc.
McNally-Pittsburg Mfg. Corp.
Mechanical Industries, Inc.—"OERFAN," "IMPINGO"
Pangborn Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wheelabrator Corp.—"DUSTUBE"

DUST COLLECTORS, MINE & DRILL

Acme Machinery Co.
American Air Filter Co.
Browning Dust Collector Co.
Ducon Co.
J. H. Fletcher & Co.
Goodman Mfg. Co.
Mayheu Supply Co., Inc.
Mechanical Industries, Inc.
Mine Safety Appliances Co.
Pangborn Corp.
Schroeder Bros.
Western Precipitation Corp. — "MULTI-CLONE"

DUST COLLECTORS, VACUUM

Acme Machinery Co.
Mechanical Industries, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
U. S. Hoffman Machinery Corp., Industrial Div.

DUST CONTROL SYSTEMS, LIQUID

Johnson-March Corp.

DUST COUNTS

Commercial Testing & Engineering Co.

DUST-EXCLUDER BOATS

United States Rubber Co.—"MULTI FLEX"

DUST SEAL CURTAINS

United States Rubber Co.

DUSTPROOFING EQUIPMENT, COLD OIL

DUSTPROOFING EQUIPMENT, HOT OIL

Viking Machinery Sales Corp.—"VIKING"

DUSTPROOFING EQUIPMENT, LIQUID COMPOUNDS

Fuel Process Co.
Johnson-March Corp.

DUST SAMPLERS

Fisher Scientific Co.
Mayheu Supply Co., Inc.
Mechanical Industries, Inc.
Mine Safety Appliances Co.—"MIDGET IMPINGERS"
Willson Products Div., Ray-O-Vac Co.

ELBOWS, RUBBER LINED

United States Rubber Co.—"USCOCITE PLASTIC"

ELEVATORS, BELT

Bartlett, C. O., & Snow Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Continental Gin Co., Industrial Div.
Fairfield Engineering Co.
Goodrich Co., B. F., Industrial Products Div.
B. F. Goodrich Industrial Products Co.
Hewitt-Robins, Inc.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
Meckum Engrg. Co.
New York Belting & Packing Co.—"ARI-MEX," "INDESTRUCTABLE," "IN-SPIRATION," "PALISADE"
Ore Reclamation Co.
K. Prins & Associates
Republic Rubber Div.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
United States Rubber Co.—"USCOLITE PLASTIC"

ELEVATORS, BUCKET

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett, C. O., & Snow Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Nelson L. Davis Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering Works
K. Prins & Associates
Remaly Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Universal Road Machinery Co.
Wilmot Engineering Co.

ELEVATORS, MEN & SUPPLIES

Robert Holmes & Bros., Inc.
Mayo Tunnel & Mine Equipment Co.

ELEVATORS, MINE-TRANSFER, CAR-LOADING—See Elevating Conveyors

ENGINE-GENERATOR SETS

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Cummins Engine Co.
Diesel Energy Corp.
L. B. Foster Co.
General Motors Corp., Detroit Diesel Engine Div.
Harnischfeger Corp.
Homelite, Div. Textron American, Inc.—"HOMELITE"
Le Roi Div., Westinghouse Air Brake Co.
Lincoln Electric Co.—"WELDANPOWER"
Morse Bros. Machinery Co.
Murphy Diesel Co.
Nordberg Mfg. Co.—"POWER CHIEF"
Ready Power Co.—"READY-POWER"
R. H. Sheppard Co., Inc.
Waukesha Motor Co.—"ENGINATORS"
Worthington Corp.

ENGINE OILS-DIESEL

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Oil Co.
Cities Service Oil Co.
D-A Lubricant Co., Inc.
Esso Standard Oil Co.—"ESSOLUBE HD," "ESTOR HD"
L. B. Foster Co.
Gulf Oil Corp.
Hobart Bros. Co.
Phillips Petroleum Co.
Shell Oil Co.
Sinclair Refining Co.
Sun Oil Co.
Swan-Finch Oil Corp.

ENGINEERS, CONSULTING

Cement Gun Co., Inc.

ENGINEERS, CONSULTING, FLOTATION

Denver Equipment Co.

ENGINEERS, CONSULTING, CONSTRUCTION

Allen & Garcia Co.
Jack Ammann Photogrammetric Engineers, Inc.
Baton & Co., Geo. S.
Robert A. Cummings, Jr., & Associates
The Daniels Co. Contractors, Inc.
Nelson L. Davis Co.
Link-Belt Co.
Lippmann Engrg. Works
Manu-Mine Research & Development Co.
John F. Meissner Engineers, Inc.
K. Prins & Associates
Read, Davis
Robinson & Robinson
Stephens-Adamson Mfg. Co.
Taller & Cooper
United Engineers & Constructors, Inc.

ENGINEERS, CONSULTING, DESIGNING

Allen & Garcia Co.
Jack Ammann Photogrammetric Engineers, Inc.
Baton & Co., Geo. S.
Blaw-Knox Co.
Robert A. Cummings, Jr., & Associates
The Daniels Co. Contractors, Inc.
Nelson L. Davis Co.
Four Wheel Drive Auto Co.
Heyl & Patterson, Inc.
Link-Belt Co.
Peter F. Loftus Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
John F. Meissner Engineers, Inc.
Pierce Management, Inc.
Alford G. Newell
K. Prins & Associates
Read, Davis
Robinson & Robinson
Stephens-Adamson Mfg. Co.
Taller & Cooper
Templeton-Matthews Corp.
United Engineers & Constructors, Inc.
Western Machinery Co.—"WKE"

ENGINEERS, CONSULTING, ELECTRICAL

Allen & Garcia Co.
General Nuclear Corp.
Herbert S. Littlewood
Peter F. Loftus Corp.
John F. Meissner Engineers, Inc.
National Electric Coil Co.
Robinson & Robinson
Taller & Cooper
United Engineers & Constructors, Inc.

ENGINEERS, CONSULTING, GEOLOGY

E. J. Longyear Co.
Manu-Mine Research & Development Co.
John F. Meissner Engineers, Inc.
Alford G. Newell
Pennsylvania Drilling Co.
Pierce Management, Inc.
Robinson & Robinson
J. W. Woomer & Associates

ENGINEERS, CONSULTING, GEOPHYSICS, INSTRUMENTATION

Mount Sopris Instrument Corp.

ENGINEERS, CONSULTING, INDUSTRIAL

Jack Ammann Photogrammetric Engineers, Inc.
Link-Belt Co.
Lippmann Engrg. Works
Peter F. Loftus Corp.
John F. Meissner Engineers, Inc.
Robinson & Robinson
Stephens-Adamson Mfg. Co.
United Engineers & Constructors Inc.

ENGINEERS, CONSULTING, INSTRUMENT

Suverkrop Instruments

ENGINEERS, CONSULTING, MECHANICAL

General Nuclear Corp.

ENGINEERS, CONSULTING, MINING

Allen & Garcia Co.
Baton & Co., Geo. S.
Cowin & Co., Inc.
Evanson, Auchmuty & Summers
Fetterman Engineering Co.
Herold Mfg. Co.
Kirk & Cowin
Link-Belt Co.
Lippmann Engrg. Works
Peter F. Loftus Corp.
E. J. Longyear Co.
John F. Meissner Engineers, Inc.
Alford G. Newell
Nordberg Mfg. Co.
Pierce Management Inc.
Read, Davis
Robinson & Robinson
J. W. Woomer & Associates

ENGINEERS, CONSULTING, PREPARATION

Allen & Garcia Co.
Baton & Co., Geo. S.
Castanoli, Alder F.
Commercial Testing & Engineering Co.
Robert A. Cummings, Jr., & Associates
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Evanson, Auchmuty & Summers
Fairmont Machinery Co.
Fuel Process Co.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co., Inc.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.
John F. Meissner Engineers, Inc.
Alford G. Newell
Pierce Management Inc.
K. Prins & Associates

Read, Davis
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Robinson & Robinson
Templeton-Matthews Corp.
United Engineers & Constructors Inc.

ENGINEERS, CONSULTING, STRIPPING

Allen & Garcia Co.
Baton & Co., Geo. S.
Robert A. Cummings, Jr., & Associates
Evanson, Auchmuty & Summers
Fetterman Engineering Co.
Pierce Management Inc.
Robinson & Robinson

ENGINES, DIESEL

Allis-Chalmers Mfg. Co.
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton, Inc.
Cummins Engine Co.
Diesel Energy Corp.
L. B. Foster Co.
General Motors Corp., Detroit Diesel Engine Div.
Harnischfeger Corp.
Hercules Motor Corp.
Ingersoll-Rand Co.
International Harvester Co., Construction Equipment Div.
Minneapolis-Moline Co.
Murphy Diesel Co.
Nordberg Mfg. Co.
Oliver Corp.
Page Engineering Co.
R. H. Sheppard Co., Inc.
Waukesha Motor Co.
Worthington Corp.

ENGINES, DIESEL, AUTOMOTIVE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
General Motors Corp., Detroit Diesel Engine Div.
Hercules Motor Corp.
Mack Trucks, Inc.
Waukesha Motor Co.

ENGINES, DUAL-FUEL

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Chicago Pneumatic Tool Co.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Murphy Diesel Co.
Nordberg Mfg. Co.—"DUAFUEL"
Waukesha Motor Co.
Worthington Corp.

ENGINES, DUAL-FUEL, AIR COOLED

Wisconsin Motor Corp.

ENGINES, GASOLINE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Cities Service Oil Co.
Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Minneapolis-Moline Co.
Oliver Corp.
Reo Motors, Inc.
Waukesha Motor Co.

ENGINES, GASOLINE, AIR COOLED

Wisconsin Motor Corp.

ENGINES, GASOLINE, AUTOMOTIVE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Mack Trucks, Inc.
Reo Motors, Inc.
Waukesha Motor Co.

ENGINES, OIL

Allis-Chalmers Mfg. Co., Buda Div.
Cities Service Oil Co.
Hercules Motor Corp.
Waukesha Motor Co.
Worthington Corp.

EXHAUSTERS

American Blower Corp.
Buffalo Forge Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Robinson Ventilating Co.
Roots-Connersville Blower Div., Dresser Industries Inc.

EXPANSION PLUGS, ROOF-BOLTING

The Elreco Corp.—"ELRECO"
National Mine Service Co.
Ohio Brass Co.

EXPLORATION EQUIPMENT, GEOPHYSICAL

Mount Sopris Instrument Corp.

EXPLORATION SERVICE, GEOPHYSICAL

E. J. Longyear Co.

EXPLOSIVES—See also, Breakers, Coal; Blasting Agents; Liquid Oxygen Explosives

EXPLOSIVES, COAL

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"GELOBEL," "DUOBEL," "MONOBEL," "LUMPCOAL"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD METAL"
King Powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

EXPLOSIVES, ROCK

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"RED CROSS," "EXTRA," "GELEX"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD METAL"
King Powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

EXPLOSIVES, LIQUID-OXYGEN TYPE

Airmite-Midwest, Inc.

EXPLOSIVES PACKAGING, PLASTIC

Visking Corp., Plastics Div.—"VIS QUEEN"

EYEBOLTS

American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Bayonne Bolt Corp.
Bethlehem Steel Co.
Duquesne Mine Supply Co.—"REDIPT"
Robert Holmes & Bros., Inc.
Pittsburgh Knife & Forge Co.
Republic Steel Corp.—"REPUBLIC"
Upson-Walton Co.

EYE SHIELDS

American Optical Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAFI-I-SHIELD," "SAFI-I-FLEY," "AIRFLOW"
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

FABRICATORS, MACHINES, COMPONENTS

Acme Machinery Co.
Connellsville Mfg. & Mine Supply Co.
Falk Corp.
Flood City Brass & Electric Co.
Galigher Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
R. C. Mahon Co.
Meckum Engr. Co.
Ore Reclamation Co.
W. J. Savage Co.
Simplicity Engineering Co.
Vulcan Iron Works
Wellman Engineering Co., McDowell Enterprise

FABRICATORS, STEEL & STRUCTORS

Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co.
Blaw-Knox Co.
Butler Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Industrial Engrg. & Construction Co., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
R. C. Mahon Co.
Meckum Engr. Co.
Ore Reclamation Co.
Phoenix Iron & Steel Co.
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Thomas Engineering & Construction Co.
Vincennes Steel Corp.
Wellman Engineering Co., McDowell Enterprise
Wiley Mfg. Co.

FACE SHIELDS

American Optical Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co. — "FACE-GARD," "SUPERGARD," "MINI-GARD"
Ore Reclamation Co.
U. S. Safety Service Co.—"HALO"
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

FAN SIGNALS

American Air Filter Co.
Nachod & U. S. Signal Co.

FANS, VENTILATING

American Blower Corp.
Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Philip Carey Mfg. Co.—"MIAMI-CAREY"
Chelsea Products, Inc.
Clarage Fan Co.
Complete Reading Electric Co.
Coppus Engineering Corp. — "COPPUS VANO," "COPPUS VENTAIR"
The Dana Fan & Blower Corp.
Fly Ash Arrestor Corp.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"VENTA-MINE"
F. R. Hannon & Sons—"HANCO"
Hartzell Propeller Fan Co.
Ilg Electric Ventilating Co.—"ILG"
Jeffrey Mfg. Co.
Joy Mfg. Co.—"AXIVANE"
Kennedy-Van Saun Mfg. & Engrg. Corp.
Mechanical Industries, Inc.
Robbins & Meyers, Inc.—"PROPELLAIR"
Robinson Ventilating Co.
Singer Mfg. Co., Diehl Mfg. Div.
Westinghouse Electric Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.—"SILENT-VANE," "AXI-FLO," "TURBOVANE"
L. J. Wing Mfg. Co.—"WINGFOIL"

FEED DISTRIBUTORS, COAL, REVOLVING

Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

FEEDERS, APRON

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Pettibone Mulliken Co.
Pioneer Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AMSCO"
Straub Mfg. Co., Inc.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webster Mfg. Co.
Williams Patent Crusher & Pulv. Co.

FEEDERS, BELT

B-I-F Industries, Inc.—"HI-WEIGH," "ROTODIP," "ADJUST-O-FEEDER," "CHEM-O-FEEDER," "PROPORTIONEER"
Barber-Greene Co.
Bonded Scale & Machine Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Denver Equipment Co.—"ADJUSTABLE STROKE"
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hardinge Co., Inc.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.
Meckum Engr. Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Road Machinery Co.
Webster Mfg. Co.
Williams Patent Crusher & Pulv. Co.

FEEDERS, CHAIN

Ross Screen & Feeder Co.—"ROSS"

FEEDERS, CONTINUOUS-WEIGHING

B-I-F Industries, Inc.—"HI-WEIGH," "ROTODIP," "ADJUST-O-FEEDER," "CHEM-O-FEEDER," "PROPORTIONEER"
Hardinge Co., Inc.—"CONSTANT WEIGHT"
Jeffrey Mfg. Co.
Merrick Scale Mfg. Co.—"FEEDOWEIGHT"
Schaffer Poidometer Co.
Syntron Co.

FEEDERS, CHLORIDE, LIME, REAGENT, SALT, ETC.

B-I-F Industries, Inc.—"HI-WEIGH," "ROTODIP," "ADJUST-O-FEEDER," "CHEM-O-FEEDER," "PROPORTIONEER"
Denver Equipment Co.—"DENVER"
Fischer & Porter Co.
Galigher Co.—"GEARY"
Jeffrey Mfg. Co.
Manzel Div., Houdaille Industries, Inc.
Morse Bros. Machinery Co.
W. J. Savage Co.
Schaffer Poidometer Co.
Syntron Co.

FEEDERS, GRIZZLY

Pioneer Engineering Works

FEEDERS, MINE-CAR

Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Schoeder Bros.
Stephens-Adamson Mfg. Co.

FEEDERS, RECIPROCATING

American Conveyor Co.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engrg. Works
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
E. F. Marsh Engrg. Co.
Ore Reclamation Co.
Pioneer Engineering Works
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Transall, Inc.
Webster Mfg. Co.

FEEDERS, VIBRATING

Barber-Greene Co.
Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Manufacturing Co.
Fairfield Engineering Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.
Ridge Equipment Co.
Simplicity Engineering Co.—"OS-A-VEYOR"
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Syntron Co.—"VIBRA-FLOW"
Transall, Inc.
Wilmot Engineering Co.

FENCE, FIELD

American Steel & Wire Div., United States Steel Corp.—"AMERICAN"

FENCING, METAL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"REALOCK," "C F & I"
Page Steel & Wire Div., American Chain & Cable Co., Inc.

FIFTH WHEELS

A. O. Smith Co.

FILES, RASPS

Henry Disston Div., H. K. Porter Co., Inc.
Martindale Electric Co.
Salem Tool Co.
Simonds Saw & Steel Co.—"RED TANG"
Snap-on Tools Corp.

FILTER CLOTH, MEDIA

C. R. Daniels Co.
The Duriron Co., Inc.
Eimco Corp.
Filter Fabrics, Inc.
Fisher Scientific Co.
Johns-Manville—"CELITE"
Koppers Co., Inc., Metal Products Div.
Mechanical Industries, Inc.
Mine Safety Appliances Co.
National Filter Media Corp.
Newark Wire Cloth Co.
Peterson Filters & Engineering Co.—"TFR DRUM"
Riegel Textile Corp.—"RIEGEL"

FILTER CLOTH, METALLIC

W. S. Tyler Co.

FILTERS, AIR

American Air Filter Co.
Bowser, Inc.
A. W. Cash Valve Mfg. Corp.
Coppus Engineering Corp.
Ducon Co.
Filter Fabrics, Inc.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.—"PLIATRON"
Lincoln Engrg. Co.—"FULFLO"
Mechanical Industries, Inc.—"IMPINGO"
Mine Safety Appliances Co.
New Jersey Meter Co.—"DRI AIR"

R. W. Nichols Co.
Victor Equipment Co.
Western Precipitation Corp.—"DUALAIRE"

FILTERS, DISK, DRUM, VACUUM

Bird Machine Co.
Bowser, Inc.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Eimco Corp.
Filter Fabrics, Inc.
Koppers Co., Inc., Metal Products Div.—"AERO TURN"
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.—"TPA DISC"

FILTERS, HORIZONTAL

Bird Machine Co.
Bowser, Inc.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Eimco Corp.
Filter Fabrics, Inc.

FILTERS, FUEL, HYDRAULIC & LUBE OILS

Bowser, Inc.
A. W. Cash Valve Mfg. Corp.
Compton, Inc.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Filter Fabrics, Inc.
Marvel Engr. Co.
R. W. Nichols Co.
Schroeder Bros.
Trabon Engineering Co.
United States Rubber Co.—"A.C. OIL"

FILTERS, MAGNETIC

Magnetic Engrg. & Mfg. Co.

FILTERS PRESSURE

Galigher Co.—"GALIGHER"

FILTERS, WATER

B-I-F Industries, Inc.—"PURECEL"
Bird Machine Co.
Bowser, Inc.
A. W. Cash Valve Mfg. Corp.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Marvel Engr. Co.
Permutit Co.

FIRE ALARMS

Walter Kidde & Co., Inc. — "KIDDE-ATMO"
United States Rubber Co.

FIRE TRUCKS, APPARATUS

American-LaFrance Corp. — "AMERICAN LA FRANCE"
American-Marsh Pumps, Inc.
Ansul Chemical Co.—"ANSUL"
Four Wheel Drive Auto Co.
Mack Trucks, Inc.
Mine Safety Appliances Co.

FIRE BRICK

Johns-Manville—"J-M"
Mexico Refractories Co.

FIRE CARS, TRUCKS, UNDERGROUND

Irwin Foundry & Mine Car Co.
Mine Safety Appliances Co.

FIRE-EXTINGUISHER FLUIDS

American-LaFrance Corp.
American Minechem Co.
Fyr-Fyter Co.
Stop Fire, Inc.
United States Rubber Co.

FIRE EXTINGUISHERS

American-LaFrance Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.—"ANSUL"
Fyr-Fyter Co.
Guyan Machy. Co.—"KIDDE"
Walter Kidde & Co., Inc.—"FYRE-FREEZ," "KIDDE"
National Mine Service Co.
Pulmosan Safety Equip. Co.
Stop Fire, Inc.—"STOP-FIRE"
Swan-Finch Oil Corp.—"AEROSOL"
United States Rubber Co.

FIRE HOSE

American-LaFrance Corp.—"AMERICAN LA FRANCE," "GOODYEAR"
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Fisher Scientific Co.
Fyr-Fyter Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.—"MALTESE CROSS"
New York Belting & Packing Co.—"AFMIC," "DELTA CARBOLIZED," "DUNDEE"
Quaker Rubber Div., H. K. Porter Co., Inc. —"QUAKER," "QUAKER PIONEER"
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC"
Thermoid Co., Industrial Div.
United States Rubber Co.

FIRE NOZZLES

Bete Fog Nozzle, Inc.

FIRE-PROTECTION SYSTEMS

American-LaFrance Corp.—"ALFITE CO_2," "FOAMITE AIRFOAM"
Cardox Corp.
Fyr-Fyter Co.
Grinnell Co., Inc.
Walter Kidde & Co., Inc.—"KIDDE CARBON DIOXIDE"

FIRST-AID EQUIPMENT

Ansul Chemical Co.—"ANSUL"
E. D. Bullard Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co. — "ALL-WEATHER"
National Mine Service Co.
Pulmosan Safety Equip. Co.

FITTINGS, GREASE

Guyan Machy. Co.—"ALEMITE"
Keystone Lubricating Co.
Ore Reclamation Co.
Stewart-Warner Corp., Alemite Div.

FITTINGS, TUBE

Weatherhead Co., Fort Wayne Div.

FLAME SAFETY LAMPS

Mine Safety Appliances Co.
National Mine Service Co.

FLANGED MOUNTINGS, ANTI-FRICTION BEARING

SKF Industries, Inc.

FLASHLIGHTS, SAFETY & INDUSTRIAL

E. D. Bullard Co.
General Scientific Equipment Co.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.
National Carbon Co., Div. Union Carbide & Carbon Corp.—"EVEREADY"
Pulmosan Safety Equip. Co.

FLOAT & SINK TEST SOLUTIONS

American Minechem Co.—"CERTIGRAV"

FLOAT & SINK TESTERS

Commercial Testing & Engineering Co.
Robert Holmes & Bros., Inc.
Reich Bros. Mfg. Co., Inc.—"DELATESTER"

FLOCCULATING AGENTS

American Cyanamid Co., Mineral Dressing Dept.—"AEROFLOC"
American Minechem Co.—"CHEMFLOC"
Robert A. Cummings, Jr., & Associates—"SUPERFLOC"
Denver Equipment Co.
Hercules Powder Co.

FLOODLIGHTS

Crouse-Hinds Co.
General Electric Co., Lamp Div.
Graybar Elec. Co., Inc.
Homelite, Div. Textron American, Inc.—"HOMELITE"
National Mine Service Co.
Phoenix Metal Products

FLOODLIGHTS, PORTABLE

Mine Safety Appliances Co.

FLOOR PLATE

U. S. Steel Corp.

FLOOR RESURFACERS

Steelcote Co.—"FLOOR-NU"
Stonhard Co.—"STONPACH," "STONCAP"

FLOORING, OPEN STEEL

Blaw-Knox Co.

FLOTATION CONDITIONERS

American Minechem Co.
Denver Equipment Co.—"DENVER"
Morse Bros. Machinery Co.
Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION FROTHERS

American Cyanamid Co., Mineral Dressing Dept.—"AERO FROTH"
American Minechem Co.
Denver Equipment Co.

FLOTATION LAB MACHINES

Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION MACHINES

American Well Works
Bulkley, Dunton Processes, Inc.
Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
Ore Reclamation Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stearns-Roger Mfg. Co.
Western Machinery Co.—"WEMCO-FAGERGREN"
Wilmot Engineering Co.

FLOTATION PLANTS, PORTABLE

Bulkley, Dunton Processes, Inc.
Denver Equipment Co.—"DENVER SUB-A"
Kennedy-Van Saun Mfg. & Engrg. Corp.

FLOTATION REAGENTS

American Cyanamid Co., Mineral Dressing Dept.
American Minechem Co.—"CHEMFROTH"
Robert A. Cummings, Jr., & Associates—"SUPERFLOC"
Denver Equipment Co.
The Dow Chemical Co.—"DOWFROTH 250"
General Mills, Inc.
Hercules Powder Co.
Shell Oil Co.

FLOTATION TESTING LABORATORIES

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
Galigher Co.

FLOW METERS
B-I-F Industries, Inc.

FLUIDS, HYDRAULIC—See Hydraulic Fluids

FOOTMATS
Onox, Inc.

FORGINGS, UPSET
General Motors Corp., New Departure Div.

FREEZEPROOFING CHEMICALS
American Minechem Co.
Fuel Process Co.
Morton Salt Co.—"FORMULA 5"
Shell Oil Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

FUEL-INJECTION EQUIPMENT
Kennedy-Van Saun Mfg. & Engrg. Corp.

FURNACE ENCLOSURES
Bigelow-Liptak Corp.

FURNACE, WALLS AND ARCHES
George P. Reintjes Co.

FURNACES, HEAT TREATING
Hevi-Duty Electric Co.

FURNACES, LABORATORY COMBUSTION
Central Scientific Co.
Fisher Scientific Co.
Hevi-Duty Electric Co.

FURNACES, METAL-MELTING
Kuhlman Elec. Co.

FURNACES, PLANT-HEATING, DIRECT-FIRED WARM-AIR
E. K. Campbell Co.—"THERMIDAIRE"

FURNACES, ARCH AND WALL CONSTRUCTION
Bigelow-Liptak Corp.

FURNACES, HEAT DRYING
Bigelow-Liptak Corp.
Colorado Iron Works—"SKINNER"
Kennedy-Van Saun Mfg. & Engrg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Westinghouse Electric Corp.

FURNACES, HEATING
E. K. Campbell Co.—"THERMIDAIRE"
Dallas Engineers Inc., Coal-O-Matic Div.

FURNACES, WARM-AIR, HEAVY-DUTY
E. K. Campbell Co.—"THERMIDAIRE"

FUSE, DETONATING
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Ensign-Bickford Co.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE, SAFETY, BLASTING
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Ensign-Bickford Co.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE HOLDERS, BLASTING
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE HOLDERS, ELECTRICAL
The Bryant Electric Co.
Bussmann Mfg. Co.—"BUSS"
Complete Reading Electric Co.
General Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Square D Co.

FUSE REDUCERS, ELECTRICAL
Bussmann Mfg. Co.—"BUSS"
Complete Reading Electric Co.
Holub Industries, Inc.
Ideal Industries, Inc.
Square D Co.
Trico Fuse Mfg. Co.

FUSES, ELECTRICAL
Bussmann Mfg. Co.—"BUSS FUSETRON"
Complete Reading Electric Co.
Cooke-Wilson Electric Supply Co.
Economy Fuse & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Trico Fuse Mfg. Co.—"TRICO"
Westinghouse Electric Corp.

GAGES, LIQUID-LEVEL
Lunkenheimer Co.

GAGES, TRACK
Aldon Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Leetonia Tool Co.
Nordberg Mfg. Co.
West Virginia Steel & Mfg. Co.

GAGES, PRESSURE, VACUUM
The Bristol Co.—"BRISTOLS"
Byron Jackson Div., Borg-Warner Corp.
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division
R. W. Nichols Co.
Victor Equipment Co.

GALVANOMETERS, BLASTING
American Cyanamid Co., Explosives Dept.

GAS DETECTORS, MINE
General Scientific Equipment Co.
Mine Safety Appliances Co.—"W-8 METHANE, E-2 METHANE"
National Mine Service Co.

GAS MASKS
E. D. Bullard Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"ALL-SERVICE"
Pulmosan Safety Equip. Co.
Willson Products Div., Ray-O-Vac Co.

GASKETS & MATERIALS
Anchor Packing Co.
Garlock Packing Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.—"PALMETTO"
Hewitt-Robins, Inc.
Johns-Manville — "GOETZE SPIROTALLIC"
New York Belting & Packing Co.—"TIRO GREAT SEAL INDESTRUCTIBLE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

GASOLINE HAMMERS
Syntron Co.

GEAR DRESSING
Swan-Finch Oil Corp.—"AEROSOL"

GEARMOTORS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Louis Allis Co.
Century Electric Co.
J. D. Christian Engineers — "RITE-LO-SPEED"
Continental Gin Co., Industrial Div.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Falk Corp. — "MOTOREDUCERS ALL-MOTOR"
Foote Brothers Gear & Machinery Corp.
James Gear Mfg. Co., D. O.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Philadelphia Gear Works
Reliance Elec. & Eng. Co.
W. J. Savage Co.
Transall, Inc.
Westinghouse Electric Corp.

GEARS
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Flood City Brass & Electric Co.
Foote Brothers Gear & Machinery Corp.—"DUTI-RATED"
Four Wheel Drive Auto Co.
James Gear Mfg. Co., D. O.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
S. P. Kinney Engineers, Inc.
Link-Belt Co.
Marathon Coal Bit Co.
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
Penn Machine Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
W. J. Savage Co.
The Tool Steel Gear & Pinion Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Bertrand P. Tracy Co.
Transall, Inc.
Vulcan Iron Works
West Virginia Armature Co.
Westinghouse Electric Corp.
Wilmot Engineering Co.

GEARS, MINE-LOCOMOTIVE, HEAT-TREATED
Penn Machine Co.

GEARS, PLASTIC
United States Rubber Co.

GEARS, SEMI-STEEL
McLanahan & Stone Corp.

GEARS, WORM
Cone-Drive Gears Div., Michigan Tool Co.

GEOPHYSICAL SURVEYS, AIRBORNE
Fairchild Aerial Surveys, Inc.

GLOVES
American Optical Co.
General Scientific Equipment Co.
Goodrich Co., B. F., Industrial Products Div.
Johns-Manville
Mine Safety Appliances Co.—"ALL-PURPOSE"
Pulmosan Safety Equip. Co.
Riegel Textile Corp. — "RIEGEL NO-BREAK-IN"

GLOVES, RUBBER
Continental Rubber Works
Fisher Scientific Co.
General Scientific Equipment Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Rubber Co.

GOGGLE-CLEANING STATIONS
American Optical Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-I-CUP"

GOGGLES
American Optical Co.
Bausch & Lomb Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Marathon Coal Bit Co.
Martindale Electric Co.
Mine Safety Appliances Co.—"SOFTSIDES"
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-I-CUP"
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

GRADER BLADES
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Steel Foundries—"WEARPACT"
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"CF&I"
Electric Steel Foundry Co.
Galion Iron Works & Mfg. Co.

GRADERS, MOTOR
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"
LeTourneau-Westinghouse Co.
Pettibone Mulliken Co.

GRAPHITE, LUBRICATING & GREASES
American Oil Co.
Joseph Dixon Crucible Co.
Fiske Bros. Refining Co., Lubriplate Div.
Jet-Lube, Inc.
Keystone Lubricating Co.
New York & New Jersey Lubricant Co.
Shell Oil Co.
Sinclair Refining Co.

GRATING, FLOOR, STAIR
Butler Mfg. Co.
Dravo Corp.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Minnesota Mining & Mfg. Co.—"SAFETY-WALK"
J. Z. Zurn Mfg. Co.—"ZURN"

GREASES
American Oil Co.
Ashland Oil & Refining Co.
Cities Service Oil Co.
Esso Standard Oil Co.
Gulf Oil Co.
Hulburt Oil & Grease Co.—"RED GREASE"
Sinclair Refining Co.
Standard Oil Co. (Ind.)—TEXAS CO.

GREASE-LINE EXTENSIONS
Clarkson Mfg. Co.—"CLARKSON"

GRINDERS, STATIONARY
Cincinnati Electrical Tool Co.
Fisher Scientific Co.
L. B. Foster Co.
Lippmann Engrg. Works
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Standard Electric Tool Co.

GRINDERS, PEDESTAL, TOOL
South Bend Lathe Works

GRINDERS, PORTABLE
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
Cleco Div., Reed Roller Bit Co.
L. B. Foster Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Ingersoll-Rand Co.
Mall Tool Co.—"MALL"
Joseph T. Ryerson & Son, Inc.
Thor Power Tool Co.

GRINDING WHEELS
Allison Div., American Chain & Cable Co., Inc.
Guyan Machy. Co.
Kennametal, Inc.
Marathon Coal Bit Co.
Minnesota Mining & Mfg. Co.—"PG"
New Era Engineering Co., Dept. G-76—"NEECO"
Norton Co.—"ALUNDUM CRYSTOLON"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Thor Power Tool Co.
United States Rubber Co.

GRINDING WHEELS, DIAMOND
Hoffman Brothers Drilling Co.
Norton Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
J. K. Smit & Sons—"SECOMET"

GRIZZLIES
American Brake Shoe Co., Amsco Div.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Prudential Plaza
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co.—"SYMONS"
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co. — "LIVE-ROLL"
Syntron Co.—"GRIZZLIES, VIBRATING"
Traylor Engineering & Mfg. Co.
W. S. Tyler Co. — "TY-ROCK TYLER NIAGARA"
Universal Engineering Co.

GRIZZLY BARS
American Brake Shoe Co., Amsco Div.
American Steel Foundries, Prudential Plaza —"WEARPACT"
Colorado Fuel & Iron Corp., Continental Oil Bldg., Denver, Colo., Wickwire Spencer Steel Div.—"C F & I"
Connellsville Mfg. & Mine Supply Co.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
National Malleable & Steel Castings Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

GROUND CLAMPS
Albert & J. M. Anderson Mfg. Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
Duquesne Mine Supply Co.
Erico Products, Inc.—"CADDY"
Graybar Elec. Co., Inc.
Mosebach Elecrtic & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"
Tweco Products, Inc.—"TWECO"
Victor Equipment Co.

GROUND RODS
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Graybar Elec. Co., Inc.
St. Louis Screw & Bolt Co.

GROUSER BARS
American Brake Shoe Co., Amsco Div.

GROUTING
Hoffman Brothers Drilling Co.
E. J. Longyear Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sika Chemical Corp.
Sprague & Henwood

GROUTING EQUIPMENT
Koehring Co.
Sprague & Henwood

HACK-SAW BLADES
Henry Disston Div., H. K. Porter Co., Inc.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"DISSTON"
Simonds Saw & Steel Co.—"RED END"
Snap-on Tools Corp.
Thor Power Tool Co.

HAMMERS, AIR
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Complete Reading Electric Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
R. W. Nichols Co.
Penn Machine Co.
Schroeder Bros.
Thor Power Tool Co.
Worthington Corp.

HAMMERS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.

HAMMERS, REPLACEABLE SOFT-FACE
Greene, Tweed & Co.—"BASA"
Snap-on Tools Corp.

HANDLES, TOOL

Dooley Brothers
Leetonia Tool Co.
Marion Handle Mills, Inc.—"ACE, VIRGINIAN, A GRADE"
Salem Tool Co.

HARDFACING FLUXES

Lincoln Electric Co.

HANGERS, SHAFT—See Shaft Hangers

HARDFACING MATERIALS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Alloy Rods Co.
American Brake Shoe Co., Amsco Div.
Ampco Metal, Inc.—"AMPCO TRODE"
Coast Metals, Inc.
Crucible Steel Co. of America, Henry W. Oliver Bldg.—"REXWELD®"
Eutectic Welding Alloys Corp.—"EUTECHROMS"
Lincoln Electric Co.—"ABRASOWELD," "MANGANWELD," "TUNGSWELD," "JET-HARD BU 90," "FACEWELD," "SURFACE-WELD," "STAINWELD," "TOULWELD"
Marathon Coal Bit Co.
Resisto-Loy Co., Inc.—"RESISTO-LOY, ISOROD, MANGA-TONE, NM"
Sight Feed Generator Co.—"REXARC"
Stoody Co.
Stulz-Sickles Co.—"SEACO"
Taylor-Wharton Co. Div.
Victor Equipment Co.
Wall Colmonoy Corp.—"COLMONOY," "COLMONOY SWEAT-ON PASTE"
West Virginia Armature Co.

HAULERS, FLAT-BED

LeTourneau-Westinghouse Co.

HAULING UNITS

Athey Products Corp.

HAULING UNITS, RUBBER TIRED

Athey Products Corp.

HEADLIGHTS

American Mine Door Co.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Lamp Div.
Guyan Machy. Co.—"GUYAN"
Imperial-Cantrell Mfg. Co.—"I. C."
Jeffrey Mfg. Co.
Schroeder Bros.

HEATER PANELS & UNITS

United States Rubber Co.—"USKON"

HEATERS, HOSE

United States Rubber Co.

HEATERS, OIL

C. R. Daniels Co.
Dravo Corp.
Hauck Mfg. Co.

HEATERS, UNIT

American Air Filter Co.
American Blower Corp.—"VENTURAFIN"
Buffalo Forge Co.
E. K. Campbell Co.—"THERMIDAIRE"
Clarage Fan Co.
Dravo Corp.
Graybar Elec. Co., Inc.
Ilg Electric Ventilating Co.—"ILG"
Westinghouse Electric Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.—"SPEEDHEATERS"
L. J. Wing Mfg. Co.—"WING REVOLVING"
Worthington Corp.

HEATING CABLE, LEAD-SHEATHED

Rockbestos Products Corp.

HEATING PLANTS

Axeman-Anderson Co.
Canton Stoker Corp.
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS

Colorado Iron Works—"AKINS"
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Denver Equipment Co.—"DECO"
Jeffrey Mfg. Co.
Simplicity Engineering Co.
Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATION PROCESS

American Cyanamid Co., Mineral Dressing Dept.
Colorado Iron Works—"AKINS"
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Dravo Corp.
Fairmont Machinery Co.
Fuel Process Co.
Jeffrey Mfg. Co.
Link-Belt Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stearns Magnetic, Inc.
Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATORS

Hardinge Co., Inc.

HINGES, MINE-DOOR

Clarkson Mfg. Co.—"CLARKSON"

HITCHINGS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
National Malleable & Steel Castings Co.
Pittsburgh Knife & Forge Co.
Sanford Day Iron Works, Inc.

HOIST CONTROLLERS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Electric Controller & Mfg. Co., Div., Square D Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Morse Bros. Machinery Co.
Shepard Niles Crane & Hoist Corp.
Square D Co.
Vulcan Iron Works

HOIST HOOKS

American Hoist & Derrick Co.—"CROSBY, LAUGHLIN"
E. D. Bullard Co.
Duquesne Mine Supply Co.
Shepard Niles Crane & Hoist Corp.
Upson-Walton Co.

HOIST SIGNALLING, COMMUNICATION

Femco, Inc.—"CAGEPHONE"
Mine Safety Appliances Co.—"HOIST PHONE"

HOISTS, AIR

Gardner-Denver Company
Ingersoll-Rand Co.

HOISTS, CONSTRUCTION

American Hoist & Derrick Co.

HOISTS, ELECTRIC

American Engineering Co.
J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"QUIK-LIFT"
Clyde Iron Works, Inc.
L. B. Foster Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"SHAW-BOX"
Harnischfeger Corp.—"ZIP-LIFT," "HEVI-LIFT"
Robert Holmes & Bros., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD LIFTER"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stearns-Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works
Wellman Engineering Co., McDowell Enterprise
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, FIGURE EIGHT

McLanahan & Stone Corp.

HOISTS, HAND

J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"SAFETY PULL," "SUPER POWER"
Denver Equipment Co.—"DENVER"
L. B. Foster Co.
Graybar Elec. Co., Inc.
Harnischfeger Corp.
Robert Holmes & Bros., Inc.
Lug-All Co.—"LUG ALL"
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUG-IT," "SHAW BOX"
Morse Bros. Machinery Co.
Ore Reclamation Co.
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Stephens-Adamson Mfg. Co.
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOIST, LAYER-LOADING

Robert Holmes & Bros., Inc.
Sanford Day Iron Works, Inc.

HOISTS, LOADING-BOOM

Clyde Iron Works, Inc.
Morse Bros. Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, MONORAIL

American Engineering Co.
Coffing Hoist Div., Duff-Norton Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUG-IT," "SHAW BOX"
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Shepard Niles Crane & Hoist Corp.
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, PORTABLE

Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.
Denver Equipment Co.—"DENVER"
Flood City Brass & Electric Co.
L. B. Foster Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"BUDGIT"
Harnischfeger Corp.
Ingersoll-Rand Co.
Joy Mfg. Co.
Lug-All Co.—"LUG-ALL"

Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUG-IT," "SHAW BOX"
Robbins & Meyers, Inc.
Ruger Equipment, Inc.
Joseph T. Ryerson & Son, Inc.
Schroeder Bros.
Shepard Niles Crane & Hoist Corp.
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, SCRAPER

American Hoist & Derrick Co.—"AMERICAN"
Ingersoll-Rand Co.
Joy Mfg. Co.
Sauerman Bros., Inc.

HOISTS, SHAFT

Clyde Iron Works, Inc.
Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, SKIP

Link-Belt Co.

HOISTS, SLOPE

Clyde Iron Works, Inc.
Robert Holmes & Bros., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, TRUCK-BODY

Galion Allsteel Body Co.
Gar Wood Industries, Inc.
The Heil Co.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.
Vickers, Inc., Tulsa Winch Div.

HOLDBACKS, CONVEYER

Stephens-Adamson Mfg. Co.

HOPPERS—See Bins & Hoppers, Storage & Blending

HOPPERS, WEIGH

Robert Holmes & Bros., Inc.
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.

Stephens-Adamson Mfg. Co.

HOSE, AIR

Acme Machinery Co.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Cooke-Wilson Electric Supply Co.
Elmco Corp.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"REVELATION"
Hewitt-Robins, Inc. — "MONARCH," "AJAX," "HEWITT," "MALTESE CROSS"
Joy Mfg. Co.
Lincoln Engrg. Co.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE"

Olin-Mathieson Chemical Corp., Explosives Div.
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TOWER"
Schroeder Bros.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

HOSE, FIRE

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"UNDERWRITERS"
Hewitt-Robins, Inc.—"AJAX," "MONARCH," "MALTESE CROSS"
Mine Safety Appliances Co.
New York Belting & Packing Co. — "AFMIC," "DELTA CARBOLIZED," "DUNDEE"
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.

HOSE, FLEXIBLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Chiksan Co.
Cobra Metal Hose, Div., DK Mfg. Co.
Compton, Inc.
Farris Flexible Valve Corp.—"FLEX VALVE"
Flexaust Co.—"FLEXAUST"
Flexible Tubing Co.
Franklin Plastics, Inc.—"DUR X PLASTIC"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE"
R. W. Nichols Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, FLEXIBLE METAL

Cobra Metal Hose, Div., DK Mfg. Co.

HOSE, FLEXIBLE, MINE

Acme Machinery Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Elmco Corp.
Franklin Plastics, Inc.—"DUR X PLASTIC"
Flexible Tubing Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE"

Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co., Industrial Div.
Thor Power Tool Co.

HOSE, GAS

United States Rubber Co.

HOSE, GREASE & OIL

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
Lincoln Engrg. Co.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "PRESSURE FLEX"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Stewart-Warner Corp., Alemite Div.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
Weatherhead Co., Fort Wayne Div.

HOSE, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Blackhawk Mfg. Co.
Carlyle Rubber Co., Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Cooke-Wilson Electric Supply Co.
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Guyan Machy. Co.—"EASTMAN"
Hewitt-Robins, Inc.
Hose Accessories Co.
Joy Mfg. Co.
Mining Machine Parts, Inc.
National Mine Service Co.
New York Belting & Packing Co.—"INDESTRUCTIBLE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"WIRETEX"
Schroeder Bros.
Tamping Bag Co.—"SEAL-TITE"
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, ROCK-DUST

Mine Safety Appliances Co.

HOSE, STEAM

United States Rubber Co.

HOSE, SUCTION, DISCHARGE

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
New York Belting & Packing Co.—"STERLING," "CLIFTON," "DOUBLE DIAMOND," "OLD GOLD," "PARA"

Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.

HOSE, WATER

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
Franklin Plastics, Inc.—"DUR X PLASTIC"
Gates Rubber Co.
Gering Products, Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"STAPLE"
Hewitt-Robins, Inc. — "MONARCH," "AJAX," "HEWITT"
Lincoln Engrg. Co.
New York Belting & Packing Co.—"STERLING CORD," "MAGIC," "GREAT SEAL," "DOUBLE DIAMOND," "INDESTRUCTIBLE," "JUBILEE"
Ore Reclamation Co.
Plymouth Rubber Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TONKA"
Thermoid Co., Industrial Div.
Thor Power Tool Co.
United States Rubber Co.

HOSE CLAMPS

United States Rubber Co.

HOSE FITTINGS

Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
Hose Accessories Co.
Joy Mfg. Co.—"SURGE PRUF"
Lincoln Engrg. Co.
Mining Machine Parts, Inc.
New York Belting & Packing Co.
Schroeder Bros.
Thermoid Co., Industrial Div.
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, DETACHABLE & REUSABLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hose Accessories Co.
C. B. Hunt & Son, Inc.—"QUIK-AS-WINK"
Joy Mfg. Co.—"SURGE PRUF"
Lincoln Engrg. Co.—"LOK-TITE"
Mining Machine Parts, Inc.
New York Belting & Packing Co.—"SINGLE STAR"
Schroeder Bros.
Thermoid Co., Industrial Div.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Compton, Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hose Accessories Co.
Joy Mfg. Co.—"SURGE PRUF"
New York Belting & Packing Co.
Schroeder Bros.
Thermoid Co., Industrial Div.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, SWAGED

Weatherhead Co., Fort Wayne Div.

HYDRAULIC CYLINDERS

Acme Machinery Co.
American Brake Shoe Co., Denison Eng'g Co. (Sub.)
Blackhawk Mfg. Co.
The Commercial Shearing & Stamping Co.
Joy Mfg. Co.
Ledeen Mfg. Co.
New York Air Brake Co.
R. W. Nichols Co.
Schroeder Bros.
R. H. Sheppard Co., Inc.
Star Jack Co., Inc.
Vickers, Inc., Div. Sperry Rand Corp.
Wellman Engineering Co., McDowell Enterprise

HYDRAULIC FLUID

American Minechem Co.
American Oil Co.
Cities Service Oil Co.
Esso Standard Oil Co.
Keystone Lubricating Co.
Shell Oil Co.
Sinclair Refining Co.
Sun Oil Co.

HYDRAULIC FLUIDS, FIRE-RESISTANT

American Minechem Co.
Keystone Lubricating Co.
Monsanto Chemical Co., Organic Chemicals Div.
Shell Oil Co.
Swan-Finch Oil Corp.

HYDRAULIC PUMPS

American Brake Shoe Co., Denison Eng'g Co. (Sub.)
American Engineering Co.
Baughman Mfg. Co., Inc.
Blackhawk Mfg. Co.
The Commercial Shearing & Stamping Co.
Compton, Inc.
DeLaval Steam Turbine Co.
Gar Wood Industries, Inc.
Joy Mfg. Co.
E. J. Longyear Co.
New York Air Brake Co.
R. W. Nichols Co.
Oliver Iron & Steel Corp.—"BERRY"
Schroeder Bros.
Star Jack Co., Inc.
Vickers, Inc., Div. Sperry Rand Corp.
Worthington Corp.

HYDRAULIC PUMPS, REBUILDING, REPAIR

Meckum Engr. Co.
Vickers, Inc., Div. Sperry Rand Corp.
West Virginia Armature Co.

HYDRAULIC VALVES

American Brake Shoe Co., Denison Eng'g Co. (Sub.)
Blackhawk Mfg. Co.
A. W. Cash Co.
The Commercial Shearing & Stamping Co.
C. B. Hunt & Son, Inc.—"QUIK-AS-WINK®"
Ledeen Mfg. Co.
Lunkenheimer Co.
New York Air Brake Co.
R. W. Nichols Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Bros.
Star Jack Co., Inc.
Vickers, Inc., Div. Sperry Rand Corp.
Walworth Co.

HYDROSEPARATORS

Bird Machine Co.
Denver Equipment Co.—"DENVER," "HYDRO-CLASSIFIER"
Dorr-Oliver, Inc.
Hardinge Co., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

INDICATORS, DATA-DISPLAY AND TRANSFER

Union Switch & Signal Div., Westinghouse Air Brake Co.

INDICATORS, REMOTE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
B-I-F Industries, Inc.
The Bristol Co.—"BRISTOLS"
Femco, Inc.
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Taller & Cooper

INDICATORS, SIGHT-FEED AND WATER

Lunkenheimer Co.

INDICATORS, TEMPERATURE

West Instrument Corp.—"VERI-TELL"

INSTRUMENTS, BLASTING-VIBRATION

King Powder Co., Inc.
W. F. Sprengnether Instrument Co., Inc.
Taller & Cooper

INSTRUMENTS, FLOW-INDICATING

New Jersey Meter Co.—"FLO-SIG," "TOOL-OM-ETER," "DRILL-OM-ETER"

INSTRUMENTS—HYDRAULIC CIRCUIT TESTING

Schroeder Bros.

INSTRUMENTS, RECORDING, PRESSURE TEMPERATURE, ETC.

B-I-F Industries, Inc.—"FLO-WATCH," "CHRONOFLO"
The Bristol Co.
Femco, Inc.
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division
Taller & Cooper
West Instrument Corp.—"MARKSMAN"
Westinghouse Electric Corp.

INSTRUMENTS, ROOF-CONTROL

Herold Mfg. Co.

INSULATING MATERIALS, ELECTRIC

Chemical Materials Dept., General Electric Co.
Complete Reading Electric Co.

Dow Corning Corp.
Duquesne Mine Supply Co.
Graybar Elec. Co., Inc.
Johns-Manville — "FIBROID," "ARMATURO," "QUINTERRD," "QUINTERRABORD," "QUINORGO," "QUINORGOBORD"
Keasbey & Mattison Co.
The Kerite Co.
Mica Insulator Co.
Minnesota Mining & Mfg. Co.—"SCOTCHFIL," "SCOTCHCAST RESIN"
Minnesota Mining & Mfg. Co., Irvington Div.
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
Shell Oil Co.
Square D Co.
United States Rubber Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

INSULATING MATERIALS, HEAT & COLD

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.—"CAREYCEL-ALL-TEMP-AIRIELL," "IMPERVO-PERFECTO-EXCEL"
Johns-Manville—"SUPEREX," "ASPESTOSPONGE," "THERMOBESTOS," "ROCK CORK," "ZEROLITE," "FIBROCEL"
Keasbey & Mattison Co.
Mexico Refractories Co.
Pittsburgh Corning Corp.—"FOAMGLAS"
Pittsburgh Plate Glass Co.—"PPG FIBER GLASS," "FOAMGLASS"
Ruberoid Co.
United States Rubber Co.

INSULATING MATERIALS, NOISE

Johns-Manville—"SPINCOUSTIC," "SINACOUSTIC," "PERMACOUSTIC," "FIBRETONE," "TRANSITE"
Keasbey & Mattison Co.
Minnesota Mining & Mfg. Co.—"SCOTCH"
Pittsburgh Plate Glass Co.—"PPG FIBRE GLASS"
United States Rubber Co.

INSULATORS, ELECTRIC

The Elreco Corp.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Ohio Brass Co.

INSULATORS, RUBBER

Continental Rubber Works

INSURANCE, CASUALTY, WORKMEN'S COMPENSATION

Bituminous Casualty Corp.
Eureka Casualty Co. (Fire Association Group)
Old Republic Insurance Co.
J. B. Pfister Co.

INSURANCE, PLANT & EQUIPMENT

Old Republic Insurance Co.
J. B. Pfister Co.

INSURANCE, SELF PROGRAMS

I. B. Pfister Co.

J-HOOKS, INSULATED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"

JACK-PIPE

Duquesne Mine Supply Co.

JACKS, AIR-OPERATED

Acme Machinery Co.
Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"RE-MO-TROL"

JACKS, BELT-TENSIONING

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, GEARED

Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, HYDRAULIC

Blackhawk Mfg. Co.
The Commercial Shearing & Stamping Co.
Cooke-Wilson Electric Supply Co.
Duff-Norton Co.
Joyce Cridland Co.
Dowty Mining Equipment
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
H. K. Porter, Inc.
Schroeder Bros.
Snap-on Tools Corp.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, PULLING

Armstrong, Bray & Co.
Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
The Nolan Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"JENNY"
Transall, Inc.

JACKS, PUSH & PULL

Armstrong, Bray & Co.
Blackhawk Mfg. Co.
Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
H. K. Porter, Inc.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, RATCHET LIFTING, LOWERING

Cooke-Wilson Electric Supply Co.
Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ROOF

Duff-Norton Co.
Duquesne Mine Supply Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"
Vulcan Iron Works

JACKS, ROOF, HYDRAULIC

Goodman Mfg. Co.
Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, SCREW

Duff-Norton Co.
Joyce Cridland Co.
Ensign Electric & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, TIMBERING

Duff-Norton Co.
Ensign Electric & Mfg. Co.
Goodman Mfg. Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JIGS, PYRITE RECOVERY

Denver Equipment Co.—"DENVER," "SELECTIVE MINERAL"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

JOINTS, UNIVERSAL

Lovejoy Flexible Coupling Co.

JOURNALS, BOXES

American Car & Foundry Div., ACF Industries, Inc.
American Crucible Products Co.
Atlas Car & Mfg. Co.
C. S. Card Iron Works
Chain Belt Co.
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Helmick Foundry-Machine Co.
Hyatt Bearings Div., General Motors Corp.
Jeffrey Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
West Virginia Armature Co.

JUNCTION BOXES, ELECTRIC, STRIPPING

Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co.

JUNCTION BOXES, ELECTRIC, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD," "GROUND-GARD"
Crouse-Hinds Co.
The Elreco Corp.—"ELRECO"
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
National Electric Products Co., Gateway Center, Bldg. 2
Ohio Brass Co.
Schroeder Bros.

KNEE PADS

General Scientific Equipment Co.
Judsen Rubber Works, Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Pulmosan Safety Equip. Co.
Salem Tool Co.

KW, KWRA, KVA, RKVA METERS

The Bristol Co.—"BRISTOLS"
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

LABORATORY EQUIPMENT

Bausch & Lomb Optical Co.
Central Scientific Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Galigher Co.
General Scientific Equipment Co.
Robert Holmes & Bros., Inc.
Laboratory Equipment Corp.—"LECO"
Mount Sopris Instrument Corp.
Sturtevant Mill Co.
W. S. Tyler Co.

LABORATORY TESTING

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
Galigher Co.
Sturtevant Mill Co.
Warner Laboratories
Western Machinery Co.—"WEMCO"

LACING, BELT

Armstrong, Bray & Co.
Flexible Steel Lacing Co.
General Splice Corp.—"MINET"

LAMP GUARDS

McGill Mfg. Co., Inc.

LAMPS, INCANDESCENT & MERCURY & VAPOR
Radiant Lamp Corp.

LAMPS, PICKING
General Electric Co., Lamp Div.

LARRIES
Chain Belt Co.
Connellsville Mfg. & Mine Supply Co.
Fairfield Engineering Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Stephens-Adamson Mfg. Co.

LARRIES, WEIGH
Bartlett, C. O., & Snow Co.
Link-Belt Co.

LATHES
Farrel-Birmingham Co., Inc.
South Bend Lathe Works

LEADING WIRE, BLASTING
American Cyanamid Co., Explosives Dept.

LEVELS, ENGINEERS
C. L. Berger & Sons, Inc.—"BERGER"
Gibraltar Equipment & Mfg. Co.
Gurley, W. & L. E.
Kern Instruments, Inc.

LEVELS, TRACK
Aldon Co.

LIGHTING, EMERGENCY
American Optical Co.—"SENTRY-LITE"
Exide Industrial Div., Electric Storage Battery Co.

LIGHTING FIXTURES
Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
Phoenix Metal Products, Metal Spinning Div.
West Virginia Electric Corp.
Westinghouse Electric Corp.

LIGHTING FIXTURES, UNDERGROUND
Femco, Inc.
Graybar Elec. Co., Inc.
Ideal Industries, Inc.

LIGHTNING ARRESTERS
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Ohio Brass Co.
Westinghouse Electric Corp.

LIGHTS, VAPOR-TIGHT, PORTABLE FLUORESCENT
Day-Ray Products, Inc.—"DAY-RAY"

LINER PLATE, CHUTES, CONVEYORS, ETC.
American Brake Shoe Co., Amsco Div.
Armco Drainage & Metal Prod., Inc.
Connellsville Mfg. & Mine Supply Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Phoenix Iron & Steel Co.
K. Prins & Associates

LINER PLATE, SHAFT & TUNNEL
Armco Drainage & Metal Prod., Inc.
The Commercial Shearing & Stamping Co.
Connellsville Mfg. & Mine Supply Co.
Phoenix Iron & Steel Co.
Republic Steel Corp.—"TRUSCON"

LININGS, CHUTE, CERAMIC
Bigelow-Liptak Corp.

LININGS, CHUTE, GLASS
Pittsburgh Plate Glass Co.—"CARRARIA"

LININGS, CHUTE, METAL
American Brake Shoe Co., Amsco Div.
Enterprise Wheel & Car Corp.
Illinois Zinc Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kensington Steel Co.
Laubenstein Mfg. Co.
Remaly Mfg. Co.
Stulz-Sickles Co.—"MANGANAL"

LININGS, CHUTE PLASTIC
Insul-Mastic Corp. of America — "POLY-PLY 5620"

LININGS, CHUTE, RUBBER
Boston Woven Hose & Rubber Co.
Galigher Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hamilton Rubber Mfg. Corp.—"ENDURANCE"
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULC IRON RUBBER"
New York Belting & Packing Co.—"KARBONITE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co., Industrial Div.
United States Rubber Co.

LININGS, CONCRETE
Bigelow-Liptak Corp.
Mayo Tunnel & Mine Equipment Co.
Sika Chemical Corp.

LININGS, FURNACE
Bigelow-Liptak Corp.
Joseph Dixon Crucible Co.
Mexico Refractories Co.

LININGS, PLASTIC
Insul-Mastic Corp. of America — "POLY-PLY B620"

LININGS, PNEUMATIC CONCRETE
Cement Gun Co., Inc.—"GUNITE"

LININGS, TANK
Cement Gun Co., Inc.—"GUNITO"

LININGS, TANK, FLUOROCARBON
Garlock Packing Co.

LININGS, TANK, GLASS
Pittsburgh Plate Glass Co.—"CARRARA & HERCULITE"
A. O. Smith Co.

LININGS, TANK, METAL
Enterprise Wheel & Car Corp.
L. O. Koven & Bro., Inc.
Magic Chemical Co.
Steelcote Co.—"STEELCOTE ERO-LUX COATINGS"

LININGS, TANK, PLASTIC
Butler Mfg. Co.

LININGS, TANK, RUBBER
Continental Rubber Works
Denver Equipment Co.—"DENVER"
Galigher Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
L. O. Koven & Bro., Inc.
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULC"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co., Industrial Div.
United States Rubber Co.

LOADERS, BUCKET
Clark Equipment Co., Construction Machinery Div.

LOADERS, PORTABLE, BELT
Athey Products Corp.

LOADERS, SHOVEL-TYPE, CRAWLERS CHAIN
Barber-Greene Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Gruendler Crusher & Pulverizer Co.
George Haiss Mfg. Co. Div., Pettibone Mulliken Corp.
Irwin Foundry & Mine Car Co.
Kremser & Sons, Inc., Frank A.
Lippmann Engrg. Works
Pettibone Mulliken Co.
Stephens-Adamson Mfg. Co.

LOADERS, SHOVEL-TYPE, CRAWLER
Allis-Chalmers Mfg. Co., Construction Machinery Div.
American Tractor Corp.—"TERRATRAC"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Caterpillar Tractor Co.—"TRAXCAVATORS"
Drott Mfg. Corp.—"SKID SHOVEL," FOUR-IN-ONE SKID SHOVEL"
Eimco Corp.
Gardner-Denver Company
Insley Mfg. Corp.
International Harvester Co., Construction Equipment Div.
Koehring Co.
Link-Belt Speeder Corp.
Morse Bros. Machinery Co.
Sanford Day Iron Works, Inc.
Tractomotive Corp.

LOADERS, SHOVEL-TYPE, RUBBER-TIRED
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Clark Equipment Co., Construction Machinery Div.
The Frank G. Hough Co.
Insley Mfg. Corp.
International Harvester Co., Construction Equipment Div.
Koehring Co.
Link-Belt Speeder Corp.
Tractomotive Corp.

LOADERS, TRACTOR
American Tractor Corp.—"TERRATRAC"
Eimco Corp.
International Harvester Co., Construction Equipment Div.
Oliver Corp.
Pettibone Mulliken Co.
R. H. Sheppard Co., Inc.

LOADERS, TRACTOR-MOUNTED
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.—"TRAXCAVATORS"
Clark Equipment Co., Construction Machinery Div.

Eimco Corp.
Goodman Mfg. Co.
International Harvester Co., Construction Equipment Div.
Joy Mfg. Co.
Morse Bros. Machinery Co.

LOADING BOOMS, APRON

Bartlett, C. O., & Snow Co.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, BELT

Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, CHAIN

Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Jeffrey Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Robert Holmes & Bros., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Transall, Inc.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, CHAIN RESCREENING

Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Transall, Inc.

LOADING-MACHINE CHECKS

Daly Ticket Co.—"DALY'S"

LOADING MACHINES, UNDERGROUND, CRAWLER

Eimco Corp.
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Speeder Corp.—"EXCALODER"
The Long Co.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAT"
Sanford Day Iron Works, Inc.

LOADING MACHINES, UNDERGROUND, RUBBER-TIRED

Clarkson Mfg. Co.—"CLARKSON," "RED-BIRD"
Jeffrey Mfg. Co.

LOADING MACHINES, UNDERGROUND, CONVERTED TRACK TO RUBBER

Jeffrey Mfg. Co.
Lee-Norse Co.

LOADING MACHINE, UNDERGROUND, TRACK-MOUNTED

Eimco Corp.
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Myers-Whaley Co.—"WHALEY AUTOMAT"

LOCKERS

The Moore Co.
Republic Steel Corp.—"REPUBLIC STEEL"

LOCK NUTS

Bearings, Inc.
Elastic Stop Nut Corp.—"ELASTIC STOP NUTS"
Link-Belt Co.
National Electric Products Co.
Palnut Co.—"PALNUT"
Republic Steel Corp.—"REPUBLIC NY-LOK"

LOCOMOTIVE, AIR

Eimco Corp.

LOCOMOTIVES, BATTERY

Atlas Car & Mfg. Co.
L. B. Foster Co.
General Electric Co., Apparatus Sales Div.
Goodman Mfg. Co.
Greensburg Machinery Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Kersey Mfg. Co., Inc.
Morse Bros. Machinery Co.
Westinghouse Electric Corp.

LOCOMOTIVES, CABLE-REEL

General Electric Co., Apparatus Sales Div.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

LOCOMOTIVES, DIESEL, SURFACE

Brookville Locomotive Works
Davenport Besler Corp.
Diesel Energy Corp.
Fairbanks Morse Co.
Fate-Root-Heath Co.
Greensburg Machinery Co.
Transall, Inc.
Vulcan Iron Works

LOCOMOTIVE, DIESEL, UNDERGROUND

Brookville Locomotive Works
Fate-Root-Heath Co.
Goodman Mfg. Co.
Greensburg Machinery Co.
Mayo Tunnel & Mine Equipment Co.
National Mine Service Co.
Transall, Inc.

LOCOMOTIVES, DIESEL-ELECTRIC

Atlas Car & Mfg. Co.
Davenport Besler Corp.
Diesel Energy Corp.
Differential Steel Car Co.
Fairbanks Morse Co.
Fate-Root-Heath Co.
L. B. Foster Co.
General Electric Co., Apparatus Sales Div.
Transall, Inc.
Vulcan Iron Works

LOCOMOTIVES, TROLLEY

Atlas Car & Mfg. Co.
Differential Steel Car Co.
L. B. Foster Co.
General Electric Co., Apparatus Sales Div.
Goodman Mfg. Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
National Mine Service Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

LOGGING EQUIPMENT, DRILL-HOLE

Mount Sopris Instrument Corp.

LUBRICANTS

Alpha Molykote Corp.—"MOLYKOTE"
Ashland Oil & Refining Co.—"ASHLAND"
Bearings, Inc.
Samuel Cabot, Inc.—"CABOT'S TASGON," CABOT'S LUBRI-TASGON"
Cities Service Oil Co.
D-A Lubricant Co., Inc.
Joseph Dixon Crucible Co.
Dow Corning Corp.
Esso Standard Oil Co.
Fiske Bros. Refining Co., Lubriplate Div.
Gulf Oil Corp.
Hulburt Oil & Grease Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Keystone Lubricating Co.
New York & New Jersey Lubricant Co.
Ohio Oil Co.
Pennsylvania Refining Co.—"PENN DRAKE"
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
Socony Mobil Oil Co.—"DTE OILS," "VIS-OLITES," "GARGOYLE COMPOUNDS,'
Standard Oil Co. (Ind.)—"STANDARD OIL"
Stewart-Warner Corp., Alemite Div.
Sun Oil Co.
Swan-Finch Oil Corp.—"AEROSOL"
The Texas Co.
Tide Water Associated Oil Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.
Warren Refining & Chemical Co.—"PLASTILUBE," "BUSTRUX," "PLASTIGEAR," "GREENGOLD," "WARCO," "STAYSIN," "THERMAX," "LITHOLUBE"
Whitmore Mfg. Co.

LUBRICATING FITTINGS

Gray & Co., Inc.
Guyan Machy. Co.
Lincoln Engrg. Co.—"BULLNECK"
Stewart-Warner Corp., Alemite Div.

LUBRICATING GUNS

Joseph Dixon Crucible Co.
Gray & Co., Inc.
Guyan Machy. Co.
Jesco Lubricants Co.
Lincoln Engrg. Co.—"LUBRIGUNS"
Nathan Mfg. Corp.—"NATHAN A P"
Schroeder Bros.
Stewart-Warner Corp., Alemite Div.

LUBRICATING SYSTEMS, AUTOMATIC

Bowser, Inc.
Farval Corp.
Gray & Co., Inc.
Lincoln Engrg. Co.—"MULTI-LUBER"
Manzel Div., Houdaille Industries, Inc.
Riggs Engineering Co.
Stewart-Warner Corp., Alemite Div.
Trabon Engineering Co.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATING SYSTEMS, CENTRALIZED

Bowser, Inc.
Farval Corp.
Lincoln Engrg. Co.—"CENTRO-MATIC"
Manzel Div., Houdaille Industries, Inc.
Nathan Mfg. Corp.—"NATHAN 'A' 'P' "
Riggs Engineering Co.

Stewart-Warner Corp., Alemite Div.
Trabon Engineering Co.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATORS

Lunkenheimer Co.

LUBRICATORS, FLANGE

Transall, Inc.

LUBRICATORS, TROLLEY-WIRE

Ohio Brass Co.

LUMBER, TREATED

T. J. Moss Tie Co.

MACHINE GUARDS, PARTS FOR

E. D. Bullard Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.

MACHINES, CUSTOM-BUILT

Clarkson Mfg. Co.

MAGNET WIRE

Complete Reading Electric Co.
Crucible Steel Co. of America
Eriez Mfg. Co.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Rome Cable Corp.

MAGNETIC SEPARATORS

Eriez Mfg. Co.
Magnetic Engrg. & Mfg. Co.

MAGNETIZING BLOCKS

Dings Magnetic Separator Co.

MAGNETITE

The Daniels Co. Contractors, Inc.
Orefraction, Inc.

MAGNETITE RECOVERY DENSIFIERS

Colorado Iron Works—"AKINS"
Western Machinery Co.—"WEMCO"

MAGNETITE RECOVERY SEPARATORS

Colorado Iron Works—"AKINS"
The Daniels Co. Contractors, Inc.
Nelson L. Davis Co.
Dings Magnetic Separator Co
Eriez Manufacturing Co.
Jeffrey Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic, Inc.
Stearns-Roger Mfg. Co.

MAGNETS, CHUTE-TYPE

Dings Magnetic Separator Co.
Electric Controller & Mfg. Co., Div. Square D Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic, Inc.
Sprout, Waldron & Co., Inc.
West Virginia Armature Co.

MAGNETS, PERMANENT NONELECTRIC, CHUTE, PULLEY, SUSPENDED

Carboloy Dept., General Electric Co.
Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
W. J. Savage Co.
Stearns Magnetic, Inc.
Transall, Inc.

MAGNETS, PULLEY-TYPE

Continental Gin Co., Industrial Div.
Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic, Inc.
Transall, Inc.

MAGNETS, SUSPENDED

Dings Magnetic Separator Co.
Electric Controller & Mfg. Co., Div. Square D Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic, Inc.

MALLETS

Goodyear Tire & Rubber Co.

MALLETS, RUBBER

Goodyear Tire & Rubber Co.

MAPS

Jack Ammann Photogrammetric Engineers, Inc.

MAPS, TOPOGRAPHIC, PHOTOGRAPHIC

Aerial Surveys, Inc.

METALLIZING EQUIPMENT

Metallizing Engrg. Co., Inc.
Wall Colmonoy Corp.—"SPRAY WELDER"

METALLIZING WIRE

Crucible Steel Co. of America

METERS, COMPRESSED-AIR

New Jersey Meter Co.—"TOOL-OM-ETER," "DRILL-OM-ETER"

METERS

Analytical Measurements, Inc.

METERS, ELECTRICAL—See Ammeters, etc.

MICROSCOPES

Bausch & Lomb Optical Co.
Fisher Scientific Co.
Mine Safety Appliances Co.

MILLISECOND CONNECTORS, DETONATING FUSE

E. I. du Pont de Nemours & Co., Inc., Explosives Div.
King Powder Co., Inc.
Olin-Mathieson Chemical Corp., Explosives Div.

MILLS, BOWL, IMPACT, SCREEN, VERTICAL

Combustion Engineering, Inc.—"C. E. RAYMOND"

MILLS, LABORATORY

American Pulverizer Co.
Central Scientific Co.
Combustion Engineering, Inc.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Sturtevant Mill Co.

MOILS

Cleco Div., Reed Roller Bit Co.
Howells Mining Drill Co.

MOISTURE METERS

The Bristol Co.—"THERMOHUMIDIGRAPH"
General Electric Co., Apparatus Sales Div.
Heyl & Patterson, Inc.—"OLIVO"
Viking Machinery Sales Corp.

MORTAR, REFRACTORY

Babcock & Wilcox Co.
Johns-Manville—"SIL-O-CEL"
Mexico Refractories Co.
Norton Co.

MOTOR CONTROLLERS, STARTERS

Allen-Bradley Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Complete Reading Electric Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div. Square D Co.
Electric Machinery Mfg. Co.
Electro Dynamics Div., General Dynamics
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.
W. J. Savage Co.
Schroeder Bros.
Square D Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

MOTOR-GENERATOR SETS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Century Electric Co.
Electric Products Co.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Harnischfeger Corp.
Hobart Bros. Co.
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Lincoln Electric Co.—"SHIELD-ARC"
The Louis Allis Co.
Master Electric Co.
Morse Bros. Machinery Co.
Reeves Pulley Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.

MOTOR REWINDING, REPAIRS

Flood City Brass & Electric Co.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co.
Joy Mfg. Co.
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

MOTORS, AC

Acme Machinery Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bonded Scale & Machine Co.
Century Electric Co.
J. D. Christian Engineers
Dooley Brothers
Electric Machinery Mfg. Co.
Electric Products Co.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse Co.
Flood City Brass & Electric Co.
L. B. Foster Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Harnischfeger Corp.
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Lincoln Electric Co.—"LINEWELD"
The Louis Allis Co.
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reeves Pulley Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
W. J. Savage Co.

Schroeder Bros.
Singer Mfg. Co., Diehl Mfg. Div.
A. O. Smith
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Thor Power Tool Co.
U. S. Electrical Motors, Inc.—"UNICLOSED VARIDRIVE SYNCROGEAR"
Wagner Electric Corp.
West Virginia Electric Corp.
West Virginia Armature Co.
Westinghouse Electric Corp.

MOTORS, AIR

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Eimco Corp.
Gardner-Denver Company
Joy Mfg. Co.—"TURBINAIR PISTONAIR"
Ingersoll-Rand Co.
R. W. Nichols Co.—"ROTO-MOTION"
Schroeder Bros.
Thor Power Tool Co.

MOTORS, DC

Acme Machinery Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Century Electric Co.
J. D. Christian Engineers
Dooley Brothers
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse Co.
Flood City Brass & Electric Co.
L. B. Foster Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Harnischfeger Corp.
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.
The Louis Allis Co.
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reeves Pulley Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
Schroeder Bros.
Singer Mfg. Co., Diehl Mfg. Div.
A. O. Smith Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

MOTORS, FLUID

Link-Belt Co.
Master Electric Co.
R. W. Nichols Co.—"ROTO MOTION"
Oliver Iron & Steel Corp.—"BERRY"
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Schroeder Bros.
Vickers Inc., Div. Sperry Rand Corp.
Westinghouse Electric Corp.

MOTORS, SEALED OIL-FILLED

Byron Jackson Div., Borg-Warner Corp.

NAILS

American Steel & Wire Div., United States Steel Corp.

NEWSLETTERS, MANAGEMENT INF., FOREMEN

Elliott Service Co., Inc.

NOZZLES, AIR, BRONZE

Lunkenheimer Co.

NOZZLES, BLASTING

Norton Co.—"NORBIDE"
Victor Equipment Co.

NOZZLES, FOG

Blaw-Knox Co.
Bete Fog Nozzle, Inc.
Carlyle Rubber Co., Inc.
Fyr-Fyter Co.
S. P. Kinney Engineers, Inc.
West Virginia Armature Co.

NOZZLES, SPRAY

Bete Fog Nozzle, Inc.
Blaw-Knox Co.
Branford Co.
Carlyle Rubber Co., Inc.
Chain Belt Co.
Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
The Duriron Co., Inc.
Fyr-Fyter Co.
Johnson-March Corp.
S. P. Kinney Engineers, Inc.
Link-Belt Co.
Viking Machinery Sales Corp.
West Virginia Armature Co.
Worthington Corp.

NOZZLES, WET ROCK DUSTING

Mine Safety Appliances Co.

NUTS

Bayonne Bolt Corp.
Bethlehem Steel Co.
Guyan Machy. Co.
Oliver Iron & Steel Corp.
Palnut Co.—"PALNUT"
Republic Steel Corp.—"REPUBLIC"
St. Louis Screw & Bolt Co.
Sheffield Steel Div., Armco Steel Corp.
Tamping Bag Co.—"SPECIAL-SAFETY"
Upson-Walton Co.

OHMMETERS, MEGOHMMETERS

The Bristol Co.—"DYNAMASTER"
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.
Westinghouse Electric Corp.

OILS HYDRAULIC—See Hydraulic Fluids

OIL SEPARATORS

Bulkley, Dunton Processes, Inc.

OILS, LUBRICATING & METAL WORKING

Sinclair Refining Co.

OILS, PENETRATING

Swan-Finch Oil Corp.—"AEROSOL"

OVENS, BAKING

Kennedy-Van Saun Mfg. & Engrg. Corp.

OVERCASTS, CORRUGATED STEEL ROUND

Armco Drainage & Metal Prod., Inc.

OVERCASTS, STEEL DEMOUNTABLE

Tri-County Building Service

OXYGEN-ADMINISTERING EQUIPMENT

General Scientific Equipment Co.
Marathon Coal Bit Co.
Mine Safety Appliances Co.—"DEMAND PNEOPHORE," "PNEOLATOR," "PNEOPHORE," "PUMONARY VENTILATOR"
Victor Equipment Co.

PACKING

Anchor Packing Co.
Boston Woven Hose & Rubber Co.
Garlock Packing Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Greene, Tweed & Co.
Guyan Machy. Co.
Hewitt-Robins, Inc.
Johns-Manville—"CENTRIPAC MOGUL," "CHEMPAC NAVALON," "JEWITT SEARINGS," "KEARSARGE SERVICE"
New York Belting & Packing Co.—"GREAT SEAL," "N Y B & P," "INDESTUCTABLE," "COBBS," "FIRO"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Spang & Company
Quaker Rubber Div., H. K. Porter Co., Inc.

PACKING, RUBBER

United States Rubber Co.

PACKING EQUIP., BAG

Bemis Bro. Bag Co.

PAINTS

Samuel Cabot, Inc.—"CABOT'S FLEXIBLAC," "CABOT'S SCOLLOPAKES"
Joseph Dixon Crucible Co.
Magic Chemical Co.—"MAGIC-VULC"
Philip Carey Mfg. Co.
E. I. du Pont de Nemours & Co., Inc.—DUCO®," "DULUX®"
Pittsburgh Plate Glass Co.—"PITTSBURGH"
Rust-Oleum Corp.
Sika Chemical Corp.
Sinclair Refining Co.
Steelcote Co.—"STEELCOTE ANTI-CORROSIVE"
Swan-Finch Oil Corp.
United States Rubber Co.
Wilbur & Williams Co.

PAINTS, ALUMINUM

Joseph Dixon Crucible Co.
Guyan Machy. Co.
Insul-Mastic Corp. of America
Magic Chemical Co.—"MAGIC-VULC"
E. I. du Pont de Nemours & Co., Inc.
Master Bronze Powder Co.—"BRUMA"
Pittsburgh Plate Glass Co.—"PITTSBURGH"
Rust-Oleum Corp.
Steelcote Co.—"STEELCOTE SILICONE ALUMINUM"
Wilbur & Williams Co.

PAINTS, REFLECTIVE

E. I. du Pont de Nemours & Co., Inc.
Insul-Mastic Corp. of America
Minnesota Mining & Mfg. Co.—"CODIT"
Pittsburgh Plate Glass Co.—"PITTSBURGH"

PANELBOARDS

The Bristol Co.—"BRISTOL'S"
Clark Controller Co.—"AMERICAN"
Crouse-Hinds Co.
The Daniels Co. Contractors, Inc.
General Electric Co., Distribution Assemblies Dept.
Graybar Elec. Co., Inc.
Hays Corp.
I-T-E Circuit Breaker Co.
Johns-Manville
Square D Co.
Westinghouse Electric Corp.

PANELS, INSTRUMENT

The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Westinghouse Electric Corp.

PARTS, DRILLING MACHINES

Stardrill-Keystone Co. — "KEYSTONE," "STOW"

PARTS, LOCOMOTIVE
Flood City Brass & Electric Co.
Goodman Mfg. Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Nathan Mfg. Corp.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MINING MACHINERY
American Brake Shoe Co., Amsco Div.
American Brake Shoe Co., National Bearing Div.
Cooke-Wilson Electric Supply Co.
Eimco Corp.
Flood City Brass & Electric Co.
Goodman Mfg. Co.
Guyan Machy. Co.
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Marathon Coal Bit Co.
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
Taylor-Wharton Co. Div.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MOTOR, ELECTRICAL
Complete Reading Electric Co.
Trombetta Solenoid Corp.—"RECIPROMOTORS," "SEMOTORS"
Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, SHUTTLE CAR
Cooke-Wilson Electric Supply Co.
Flood City Brass & Electric Co.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
National Mine Service Co.
Penn Machine Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, TRUCK
C. S. Card Iron Works
Dart Truck Co.
Henrickson Mfg. Co.

PENTAPRISMS, (RIGHT-ANGLE)
Kern Instruments, Inc.

PH INDICATORS
Analytical Measurements, Inc.
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.

PHOTOCOPY EQUIPMENT, MATERIALS
Peerless Photo Products, Inc.—"DRI-STAT"

PHOTOGEOLOGY
E. J. Longyear Co.

PHOTO PRINTING EQUIPMENT, MATERIALS
Sperry Rand Corp., Remington Rand Div.—"TRANSCOPY," "DEXIGRAPH"

PICKING TABLES
Bonded Scale & Machine Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
E. F. Marsh Engrg. Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Transall, Inc.
Wilmot Engineering Co.

PICKS
Bowdil Co.
Gilbraltar Equipment & Mfg. Co.
Leetonia Tool Co.

PILING, TREATED
T. J. Moss Tie Co.

PILLOW BLOCKS, SLEEVE-BEARING
Bartlett, C. O., & Snow Co.
Bearings, Inc.
Chain Belt Co.
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"SLEEVOIL"
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
K. Prins & Associates
Transall, Inc.
Wilmot Engineering Co.

PILLOW BLOCKS, ANTIFRICTION-BEARING
Ahlberg Bearing Co.—"AHLBERG"
Bartlett, C. O., & Snow Co.
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp. — "SC-SCM-SLP," "DODGE-TIMKEN"
Fafnir Bearing Co.
Guyan Machy. Co.—"SEALMASTER"
Hewitt-Robins, Inc.—"JONES"
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Transall, Inc.
Wilmot Engineering Co.

PIPE, ALUMINUM
Aluminum Company of America—"ALCLAD"
L. B. Foster Co.
Graybar Elec. Co., Inc.
Revere Copper & Brass Inc.
Reynolds Metals Co.

PIPE, ASBESTOS-CEMENT
Johns-Manville—"TRANSITE"
Keasbey & Mattison Co.

PIPE, BRONZE
Ampco Metal, Inc.
Goyne Pump Co.

PIPE, CAST-IRON
Goyne Pump Co.
Graybar Elec. Co., Inc.
United States Pipe & Foundry Co.
Wilmot Engineering Co.

PIPE, CEMENT-LINED
Goyne Pump Co.
Jones & Laughlin Steel Corp.
United States Pipe & Foundry Co.

PIPE, COPPER, RED BRASS
Phelps Dodge Copper Products Co.
Revere Copper & Brass Inc.
Triangle Conduit & Cable Co.

PIPE, CORROSION-RESISTANT
Duriron Co., Inc.

PIPE, CORRUGATED
Armco Drainage & Metal Prod., Inc.
Republic Steel Corp.

PIPE, DRIVE
Acker Drill Co.

PIPE, GLASS
Fisher Scientific Co.

PIPE, IRRIGATION, ALUMINUM
Aluminum Company of America
Reynolds Metals Co.

PIPE, PLASTIC
Carlon Products Corp.
Crane Co.
Fisher Scientific Co.
Franklin Plastics Inc.—"DUR X"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL," "RIGID"
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"SKYLINE"
Hamilton Rubber Mfg. Corp.—"POLYETHYLENE"
Johnson Plastics Corp.
Midland Pipe & Supply Co.
Minnesota Mining & Mfg. Co., Irvington Div.
National Mine Service Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Plastex Co.—"PLASTEX MEASURE-MARKED"
Quaker Rubber Div., H. K. Porter Co., Inc.
Republic Steel Corp.
Triangle Conduit & Cable Co.
United States Rubber Co.
Waljohn Plastics Co.
Yardley Plastics Co.—"CLEARSTREAM"
Youngstown Sheet & Tube Co.—"FIBERCAST"

PIPE, RUBBER
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
Linatex Corp. of America
New York Belting & Packing Co.—"INDESTRUCTABLE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

PIPE, RUBBER-LINED
Farris Flexible Valve Corp. — "FLEX VALVE"
Galigher Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Naylor Pipe Co.
New York Belting & Packing Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

PIPE, SLUDGE
Farris Flexible Valve Corp. — "FLEX VALVE"
Naylor Pipe Co.

PIPE, SPIRAL-WELDED
Armco Drainage & Metal Prod., Inc.
L. B. Foster Co.
Midland Pipe & Supply Co.
Naylor Pipe Co.

PIPE, STAINLESS STEEL
National Tube Div., United States Steel Corp.—"USS"

PIPE, STEEL

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
L. B. Foster Co.
Graybar Elec. Co., Inc.
Jones & Laughlin Steel Corp.
L. O. Koven & Bro., Inc.
Midland Pipe & Supply Co.
National Supply Company—"SPANG"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc.
Wheeling Steel Corp.
Youngstown Sheet & Tube Co.—"YOLOY"

PIPE, STEEL, STAINLESS

Allegheny Ludlum Steel Corp.

PIPE, STEEL-WELDED

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
L. B. Foster Co.
Jones & Laughlin Steel Corp.
L. O. Koven & Bro., Inc.
R. C. Mahon Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Naylor Pipe Co.
Phoenix Iron & Steel Co.
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc.
A. O. Smith Co.
Taylor Forge & Pipe Works
Youngstown Sheet & Tube Co.

PIPE, WOOD

Peter O. Sutphen

PIPE, WOOD-LINED STEEL

Goyne Pump Co.
Michigan Pipe Co.
Peter O. Sutphen

PIPE, WOOD-STAVE

Michigan Pipe Co.
Peter O. Sutphen

PIPE, WROUGHT-IRON

A. M. Byers Co.
Midland Pipe & Supply Co.
Wilmot Engineering Co.

PIPE, COUPLINGS

Dresser Mfg. Div., Dresser Industries, Inc.

PIPE COUPLINGS, FLEXIBLE

Victualic Co. of America—"VICTUALIC"

PIPE COVERINGS

Galigher Co.
Gustin-Bacon Mfg. Co.—"SNAP-ON"
Johns-Manville — "TRANTEX-TAPE," "TRANSHIELD-FELT"
Philip Carey Mfg. Co.—"CAREYCEL-ALL-TEMP-AIRCELL", "IMPERVO-PERFECTO EXCEL"
Ruberoid Co.

PIPE FABRICATION

Dravo Corp.
Stearns-Roger Mfg. Co.

PIPE FITTINGS

Anchor Coupling Co., Inc.
Armco Drainage & Metal Prod., Inc.
Crane Co.
Dresser Mfg. Div.
Fairbanks Co.—"DART"
Fisher Scientific Co.
Goyne Pump Co.
Grinnell Co., Inc.
Gustin-Bacon Mfg. Co.—"GRUVAGRIP"
Guyan Machy. Co.—"GRINNEL"
Midland Pipe & Supply Co.
Naylor Pipe Co.
R. W. Nichols Co.—"DEUTSCH"
Taylor Forge & Pipe Works
Tube Turns Plastics, Inc.
United States Pipe & Foundry Co.
Victaulic Co. of America
Walworth Co.
Weatherhead Co., Fort Wayne Div.

PIPE FITTINGS, STAINLESS-STEEL

Electric Steel Foundry Co.

PIPE FITTINGS, BRONZE

Ampco Metal, Inc.
Goyne Pump Co.
Grinnell Co., Inc.
Walworth Co.

PIPE FITTINGS, FLANGES-PLASTIC & WELDED

Grinnell Co., Inc.
Midland Pipe & Supply Co.
Naylor Pipe Co.
United States Rubber Co.
Walworth Co.

PIPE FITTINGS, PLASTIC

Carlon Products Corp.
Fisher Scientific Co.
Franklin Plastics Inc.—"DUR X"
B. F. Goodrich Industrial Products Co.—"KOROSEAL," "RIGID"
Grinnell Co., Inc.
Johnson Plastics Corp.
Midland Pipe & Supply Co.
National Mine Service Co.
Plastex Co.
Republic Steel Corp.—"REPUBLIC"
Triangle Conduit & Cable Co.
Tube Turns Plastics, Inc.—"TUBE TURNS"
United States Rubber Co.
Walworth Co.
Youngstown Sheet & Tube Co.

PIPE FITTINGS, RUBBER

United States Rubber Co.

PIPE FITTINGS, STAINLESS

Ladish Co.

PIPE FITTINGS, STEEL & ALLOYS

Ladish Co.

PIPE FITTINGS, WELDING

Tube Turns, Div. National Cylinder Gas Co.—"TUBE-TURN"

PIPE HANGERS

Grinnell Co., Inc.

PIPE-REPAIR CLAMPS, SLEEVES

Dresser Mfg. Div.

PIPE TOOLS

Beaver Pipe Tools, Inc.
Graybar Elec. Co., Inc.
Toledo Pipe Threading Machine Co.

PIPING SYSTEMS, FABRICATION WELDING

Galigher Co.
Grinnell Co., Inc.
R. C. Mahon Co.
Midland Pipe & Supply Co.
Walworth Co.

PISTON RINGS

Robert Holmes & Bros., Inc.
Koppers Co., Inc., Metal Products Div.—"AMERICAN HAMMERED INDUSTRIAL"

PLANERS, COAL

Mining Progress, Inc.

PLATE, ALLOY

Bethlehem Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Revere Copper & Brass Inc.
Robert Holmes & Bros., Inc.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

PLATE, FLOOR

Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.

PLATE, STEEL

Bethlehem Steel Co.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Meckum Engr. Co.
Phoenix Iron & Steel Co.
W. J. Savage Co.
Stulz-Sickles Co.—"MANGANAL"
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

PLATE, STEEL, STAINLESS

Allegheny Ludlum Steel Corp.

PLATE, WROUGHT IRON

A. M. Byers Co.

PLATE & SHEET, ALUMINUM

Aluminum Company of America
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Reynolds Metals Co.

PLATE & SHEET, ZINC

Illinois Zinc Co.

PLUGS & RECEPTACLES, HIGH & LOW CURRENT & VOLTAGE

Albert & J. M. Anderson Mfg. Co.
The Bryant Electric Co.
Crouse-Hinds Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.
United States Rubber Co.

PLUMB BOBS

Suverkrop Instruments

POLE-LINE MATERIALS

Duquesne Mine Supply Co.
Four Wheel Drive Auto Co.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Mosebach Electric & Supply Co.
Oliver Iron & Steel Corp.

POLES, TREATED

Duquesne Mine Supply Co.
Graybar Elec. Co., Inc.
T. J. Moss Tie Co.
Republic Creosoting Co.

POLLUTION-CONTROL SYSTEMS

B-I-F Industries, Inc.
Bird Machine Co.
Bulkley, Dunton Processes, Inc.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Heyl & Patterson, Inc.

POLLUTION-CONTROL SYSTEMS, AIR

American Air Filter Co.
Mechanical Industries, Inc.

POLYETHYLENE-FILM, SHEETING & TUBING

Gering Products, Inc.

PORTABLE BREAKERS

Athey Products Corp.

POSTERS, MINE SAFETY

Elliott Service Co., Inc.

POSTS, STEEL FENCE

American Steel & Wire Div., United States Steel Corp.—"AMERICAN"

POSTS, TREATED

T. J. Moss Tie Co.

POWDER BAGS, BOXES—See Bags, Boxes, Powder

POWDER STORAGE, FIELD UNITS

Atlas Powder Co.
Dravo Corp.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

POWER-FACTOR METERS, RECORDERS

The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division
Westinghouse Electric Corp.

POWER UNITS, HYDRAULIC

American Blower Corp.
American Brake Shoe Co., Denison Eng'g Co. (Sub.)
Vickers, Inc., Div. Sperry Rand Corp.
Vickers, Inc., Tulsa Winch Div.

PREPARATION BUILDERS, CONTRACTORS

The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co., Inc.
Link-Belt Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
United Engineers & Constructors Inc.
Wilmot Engineering Co.

PREPARATION PLANTS, PORTABLE

The Daniels Co. Contractors, Inc.—"DMS"
Robert Holmes & Bros., Inc.
K. Prins & Associates
Thomas Engineering & Construction Co.
United Engineers & Constructors Inc.
Western Machinery Co.—"WEMCO MOBIL-MILL"

PRESSES, HYDRAULIC

American Brake Shoe Co., Denison Eng'g Co. (Sub.)
Complete Reading Electric Co.
Farrel-Birmingham Co., Inc.
R. W. Nichols Co.

PROPS—See Roof Support, Timber

PULLERS, FUSE

Complete Reading Electric Co.
Economy Fuse & Mfg. Co.
General Scientific Equipment Co.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"TRICO"

PULLERS, GEAR & WHEEL

Armstrong, Bray & Co.—"STEELGRIP"
Bearings, Inc.
Complete Reading Electric Co.
Martindale Electric Co.
The Nolan Co.
Snap-on Tools Corp.
Templeton, Kenly & Co.—"SIMPLEX"

PULLERS, GEAR & WHEEL, HYDRAULIC

Armstrong, Bray & Co.—"HYDRAGRIP"
Bearings, Inc.
Complete Reading Electric Co.
Templeton, Kenly & Co.—"RE-MO-TROL"

PULLEYS, CAST IRON

Continental Gin Co., Industrial Div.
B. F. Goodrich Industrial Products Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
McLanahan & Stone Corp.
Transall, Inc.
Webster Mfg. Co.
T. B. Woods Sons Co.

PULLEYS, CONVEYOR—See Conveyor Pulleys, Conveyor Idler Pulleys

PULLEYS, PAPER

The American Pulley Co.
Browning Mfg. Co.

PULLEYS, RUBBER-COVERED

United States Rubber Co.

PULLEYS, SEMI-STEEL

Continental Gin Co., Industrial Div.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
McLanahan & Stone Corp.
Transall, Inc.
Webster Mfg. Co.
T. B. Woods Sons Co.

PULLEYS, STEEL

The American Pulley Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"TAPER-LOCK"
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
E. F. Marsh Engrg. Co.
Meckum Engr. Co.
Reliance Electric & Engineering Co., Reeves Pulley Co. Div.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.—"BELT-SAVER"
Transall, Inc.

PULLEYS, WOOD

J. D. Christian Engineers

PULVERIZER PARTS, MANGANESE STEEL

American Brake Shoe Co., Amsco Div.

PULVERIZERS, FURNACE-FEED

Babcock & Wilcox Co.
Combustion Engineering, Inc.—"C-E-RAYMOND"
Foster Wheeler Corp.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Majac Inc.
Williams Patent Crusher & Pulv. Co.

PULVERIZERS, LABORATORY

Central Scientific Co.
Combustion Engineering, Inc.—"C-E-RAYMOND"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Lippmann Engrg. Works
Sturtevant Mill Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv. Co.

PUMPING STATION

Acker Drill Co.

PUMP-PRIMING EQUIPMENT

Barrett, Haentjens & Co.
Carver Pump Co.
Flood City Brass & Electric Co.
Goyne Pump Co.
Nash Engineering Co.

PUMPS, AIR-DRIVEN

E. J. Longyear Co.

PUMPS, AIR-HYDRAULIC

Ledeen Mfg. Co.

PUMPS, CENTRIFUGAL

Allen-Sherman-Hoff Pump Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div., Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.
Construction Machy. Co.
Dean Brothers Pumps, Inc.
DeLaval Steam Turbine Co.
The Deming Co.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Ensign Electric & Mfg. Co.
Fairbanks Morse Co.
Flood City Brass & Electric Co.
Food Machinery & Chemical Corp., Peerless Pump Div.
Gardner-Denver Company
Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Guyan Machy. Co.—"GORMAN RUPP"
Homelite, Div. Textron American, Inc.—"HOMELITE"
Ingersoll-Rand Co.
Jaeger Machine Co.
LaBour Co., Inc.
Lancaster Pump & Mfg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
McNally-Pittsburg Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
National Mine Service Co.
New York Air Brake Co.
Pennsylvania Pump & Compressor Co.—"THRUSTFRE®"
Pettibone Mulliken Co.
Rice Pump & Machine Co.
Roots-Connersville Blower, Div. Dresser Industries Inc.
Warren Steam Pump Co.
Western Machinery Co.—"WEMCO"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, CENTRIFUGAL, SELF-PRIMING

American Well Works
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Buffalo Forge Co.
Byron Jackson Div., Borg-Warner Corp.
Chain Belt Co.
Chicago Pneumatic Tool Co.
Carver Pump Co.
Construction Machy. Co.
The Deming Co.
The Duriron Co., Inc.
Ensign Electric & Mfg. Co.
Food Machinery & Chemical Corp., Peerless Pump Div.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Guyan Machy. Co.—"GORMAN RUPP"
Homelite, Div. Textron American, Inc.—"HOMELITE"
Ingersoll-Rand Co.
Jaeger Machine Co.
LaBour Co., Inc.—"HYDROBALANCE"
Lancaster Pump & Mfg. Co.

Mall Tool Co.—"MALL"
Marlow Pumps, Div. of Bell & Gossett Co.
Nagle Pumps, Inc.
New York Air Brake Co.
Rice Pump & Machine Co.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, CONCRETE GROUTING

E. J. Longyear Co.

PUMPS, DIAPHRAGM

Barnes Mfg. Co.
Barrett, Haentjens & Co.
B-I-F Industries, Inc.—"CHEM-O-FEEDER", "ADJUST-O-FEEDER", "PROPORTIONEER"
Carver Pump Co.
Chain Belt Co.
Construction Machy. Co.
Denver Equipment Co.—"DENVER ADJUSTABLE STROKE"
Dorr-Oliver, Inc.
Eimco Corp.
Gardner-Denver Company
Gorman-Rupp Co.
Homelite, Div. Textron American, Inc.—"HOMELITE"
Guyan Machy. Co.—"GORMAN RUPP"
Jaeger Machine Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Rice Pump & Machine Co.
Western Machinery Co.—"WEMCO"
Worthington Corp.

PUMPS, DRUM

General Scientific Equipment Co
Gray & Co., Inc.
Lincoln Engrg. Co.—"AIRLINE"

PUMPS, FIRE

Porto Pump, Inc.

PUMPS, FROTH HANDLING

Denver Equipment Co.

PUMPS, HIGH VACUUM

Central Scientific Co.—"CENCO HYVAC"

PUMPS, JET

Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Byron Jackson Div., Borg-Warner Corp.
Carver Pump Co.
Construction Machy. Co.
The Deming Co.
Fairbanks Morse Co.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Jaeger Machine Co.
Lancaster Pump & Mfg. Co.
New York Air Brake Co.
Porto Pump, Inc.

PUMPS, METERING

B-I-F Industries, Inc.—"CHEM-O-FEEDER", "ADJUST-O-FEEDER", "PROPORTIONEER"
New York Air Brake Co.
Roots-Connersville Blower, Div. Dresser Industries Inc.

PUMPS, PISTON & PLUNGER

Aldrich Pump Co.
American Engineering Co.
American-Marsh Pumps, Inc.
Canton Stoker Corp.—"WAGENER"
Carver Pump Co.
Dean Brothers Pumps, Inc.
The Deming Co.
Fairbanks Morse Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Lancaster Pump & Mfg. Co.
Ledeen Mfg. Co.
E. J. Longyear Co.
National Mine Service Co.
National Supply Company—"NATIONAL"
New York Air Brake Co.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, ROTARY

The Deming Co.

PUMPS, SAND, ABRASIVE HANDLING

Denver Equipment Co.

PUMPS, SOLIDS-HANDLING

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL-CENTRISEAL"
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.
American-Marsh Pumps, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Canton Stoker Corp.—"WAGENER"
Carver Pump Co.
The Deming Co.
Dorr-Oliver, Inc.
Galigher Co.—"VACSEAL"
Gardner-Denver Company
Goulds Pumps, Inc.
Goyne Pump Co.
Gray & Co., Inc.
Guyan Machy. Co.—"WESTCO"
Ingersoll-Rand Co.
Linatex Corp. of America
Lincoln Engrg. Co.
Manzel Div., Houdaille Industries, Inc.
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
Nagle Pumps, Inc.
New York Air Brake Co.
Ore Reclamation Co.
Robbins & Meyers, Inc.—"MOYNO"
Warren Steam Pump Co.
Western Machinery Co.—"WEMCO TORQUE FLOW"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, SUBMERSIBLE

Byron Jackson Div., Borg-Warner Corp.
Lancaster Pump & Mfg. Co.

PUMPS, SUMP

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL"
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American-Marsh Pumps, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div., Borg-Warner Corp.
Carver Pump Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
The Deming Co.
Fairbanks Morse Co.
Food Machinery & Chemical Corp., Peerless Pump Div.
Galigher Co.—"GALIGHER"
Gardner-Denver Company
Gorman-Rupp Co.
Goulds Pumps, Inc.
Herold Mfg. Co.
Ingersoll-Rand Co.
Johnston Pump Co.
Lancaster Pump & Mfg. Co.
Mall Tool Co.—"MALL"
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
New York Air Brake Co.
Penn Machine Co.
Robbins & Meyers, Inc.—"MOYNO"
Schramm, Inc.
Thor Power Tool Co.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, VACUUM

Joy Mfg. Co.

PUMPS, VARIABLE DELIVERY

Nathan Mfg. Corp.

PUMPS, VERTICAL, CENTRIFUGAL

Barrett, Haentjens & Co.
Nagle Pumps, Inc.

PUMPS, VERTICAL, CENTRIFUGAL AND TURBINE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Well Works
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Buffalo Forge Co.
Byron Jackson Div., Borg-Warner Corp.
Carver Pump Co.
Dean Brothers Pumps, Inc.
The Deming Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse Co.
Food Machinery & Chemical Corp., Peerless Pump Div.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Guyan Machy. Co.—"REDA"
Ingersoll-Rand Co.
Johnston Pump Co.
Lancaster Pump & Mfg. Co.
Layne & Bowler, Inc.
Morris Machine Works
New York Air Brake Co.
Pennsylvania Drilling Co.
Warren Steam Pump Co.
Worthington Corp.

PUSHBUTTONS

Allen-Bradley Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Complete Reading Electric Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div. Square D Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Square D Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

PYROMETERS

The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division—"ELECTRONIK"
West Instrument Corp.—"GARDSMAN-VERI-TELL"

RADIO SYSTEMS

Federal Telephone & Radio Co., Div. International Telephone & Telegraph Corp.
General Electric Co., Communication Equipment
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.—"MINE PHONE"
Motorola Communications & Electronics, Inc.
Radio Corp. of America, Commercial Electronic Products

RAIL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.

U. S. Steel Corp.
West Virginia Steel & Mfg. Co.

RAIL BENDERS

Aldon Co.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
Utility Mine Equipment Co.
Watt Car & Wheel Co.

RAIL BOLTS

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
L. B. Foster Co.
Morse Bros. Machinery Co.
Oliver Iron & Steel Corp.
Pittsburgh Screw & Bolt Corp.
St. Louis Screw & Bolt Co.

RAIL-BOND TERMINALS

American Mine Door Co.

RAIL BONDS

American Steel & Wire Div., United States Steel Corp.—"TIGERWELD," "TIGER-BRAZE"
Copperweld Steel Co.—"COPPERWELD"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CAD WELD"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.—"EVERLAST SUPER-WELD"

RAIL BRACES

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
The Nolan Co.
Pettibone Mulliken Co.
West Virginia Steel & Mfg. Co.

RAIL CLAMPS

Dravo Corp.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Industrial Brownhoist Corp.
Mosebach Electric & Supply Co.
Wellman Engineering Co.
West Virginia Steel & Mfg. Co.

RAIL CROSSINGS, RUBBER

Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.

RAIL DOLLIES

Templeton, Kenly & Co.—"SIMPLEX"

RAIL DRILLS

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Mall Tool Co.—"MALL"
Nordberg Mfg. Co.
Ohio Brass Co.

RAIL FROGS

American Brake Shoe Co., Ramapo Ajax Div.
Bethlehem Steel Co.
C. S. Card Iron Works
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Morse Bros. Machinery Co.
Pettibone Mulliken Co.
West Virginia Steel & Mfg. Co.

RAIL GRINDERS

Mall Tool Co.—"MALL"

RAIL PUNCHES

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Mine Safety Appliances Co.—"VELOCITY-POWER"
National Mine Service Co.
Utility Mine Equipment Co.

RAIL SIGNAL SYSTEMS, MANUAL & AUTOMATIC

American Mine Door Co.
Cheatham Elec. Switching Device Co.
Graybar Elec. Co., Inc.
Nachod & U. S. Signal Co.

RAIL SPIKES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
Youngstown Sheet & Tube Co.

RAIL SPLICE BARS, PLATES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
West Virginia Steel & Mfg. Co.

RAIL SPRING-SWITCH SNUBBERS

Cheatham Elec. Switching Device Co.

RAIL SWITCH-POSITION INDICATORS

American Mine Door Co.
Cheatham Elec. Switching Device Co.
Flood City Brass & Electric Co.
L. B. Foster Co.
Joy Mfg. Co.
Miners' Hardware Supply Co.

RAIL SWITCHTHROWERS, ELECTRIC, AUTOMATIC

American Mine Door Co.—"ELECTRI-THROW"
Cheatham Elec. Switching Device Co.
L. B. Foster Co.
Joy Mfg. Co.

RAIL TIE HOLDERS

Leetonia Tool Co.

RAIL TIE PADS

American Brake Shoe Co., Ramapo Ajax Div.

RAIL TIE PLATES

Bethlehem Steel Co.
L. B. Foster Co.
Morse Bros. Machinery Co.
U. S. Steel Corp.
West Virginia Steel & Mfg. Co.

RAIL TIES, PRESERVATIVE TREATED

Koppers Co., Inc., Wood Preserving Div.—"WOLMANIZED"
T. J. Moss Tie Co.
Republic Creosoting Co.

RAIL TIES, STEEL

Bethlehem Steel Co.
L. B. Foster Co.
National Mine Service Co.
West Virginia Steel & Mfg. Co.

RAIL TURNOUTS, SWITCHES, STANDS

Bethlehem Steel Co.
C. S. Card Iron Works
L. B. Foster Co.
Pettibone Mulliken Co.
West Virginia Steel & Mfg. Co.

RAIL WELDING

Metal & Thermit Corp.—"THERMIT"

RAIL WELDING MATERIALS

American Brake Shoe Co., Amsco Div.

RAIL & TRACK CONTACTORS

American Mine Door Co.
Nachod & U. S. Signal Co.

RAILS, GUARD

West Virginia Steel & Mfg. Co.

RAILS, TRANSITION

C. S. Card Iron Works
Miners' Hardware Supply Co.

RECTIFIERS, GERMANIUM

General Electric Co., Semiconductor Products

RECTIFIERS, MERCURY-ARC

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"EXCITRON"
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Hackbridge & Hewittic Electric Co., Ltd.
Herbert S. Littlewood
Westinghouse Electric Corp.

RECTIFIERS, MECHANICAL

I-T-E Circuit Breaker Co.

RECTIFIERS, SELENIUM

Dings Magnetic Separator Co.
Federal Telephone & Radio Co., Div. International Telephone & Telegraph Corp.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Kersey Mfg. Co., Inc.
Syntron Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.

RECTIFIERS, SILICON

General Electric Co., Semiconductor Products

RECORDERS, OPERATING-HOUR

The Bristol Co.
General Electric Co., Apparatus Sales Div.

RECORDERS, TEMPERATURE

West Instrument Corp.—"MARKSMAN"

REFRACTORIES

Babcock & Wilcox Co.
Corhart Refractories Co.
Joseph Dixon Crucible Co.
Johns-Manville—"FIRECRETE," "BLAZE-CRETE," "HELLITE"
Norton Co.—"ALUNDUM," "CRYSTOLON," "MAGNORITE"
Philip Carey Mfg. Co.

REFRACTORIES, ABRASION-RESISTANT

Corhart Refractories Co.—"CORNAR ELECTROCAST"

REGULATORS, DRAFT

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division

REGULATORS, PRESSURE

Black, Sivalls & Bryson, Inc.
The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
Complete Reading Electric Co.
Fischer & Porter Co.
Hauck Mfg. Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
R. C. Nichols Co.—"M-B"
Rockwell Mfg. Co.
Schroeder Bros.
Victor Equipment Co.

REGULATORS, TEMPERATURE

The Bristol Co.—"BRISTOL'S"

A. W. Cash Co.
Fischer & Porter Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.—"GARDSMAN"

REGULATORS, VOLTAGE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Machinery Mfg. Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Hevi-Duty Electric Co.
Square D Co.
Westinghouse Electric Corp.

RELAYS, ELECTRIC

Allen-Bradley Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Mine Door Co.
Cheatham Elec. Switching Device Co.
Clark Controller Co.
Complete Reading Electric Co.
Cutler-Hammer, Inc.
Elastic Stop Nut Corp.—"AGASTAT"
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Heinemann Elec. Co.—"SILIC-O-NETIC"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Nachod & U. S. Signal Co.
Square D Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

RELAYS, MERCURY

Durakool, Inc.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Mining Machine Parts Inc.

RELAYS, SEALED TIME DELAY

A G A Div., Elastic Stop Nut Corp. of America

REMOTE SYSTEMS

Femco, Inc.

REPAIR SERVICE, MINE EQUIPMENT

Flood City Brass & Electric Co.
W. J. Savage Co.
Simplicity Engineering Co.

REPRODUCTION EQUIPMENT

Charles Bruning Co., Inc.

RERAILERS

Aldon Co.
American Mine Door Co.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Miners' Hardware Supply Co.
The Nolan Co.
Pettibone Mulliken Co.
Sanford Day Iron Works, Inc.

RESISTORS

Allen-Bradley Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"GUYAN"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Keystone Carbon Co.—"NTC"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Carbon Co.—"OHIOHM"
Penn Machine Co.
Post Glover Electric Co.—"P-G STEEL GRID"
Stackpole Carbon Co.
Westinghouse Electric Corp.

RESPIRATORS

American Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Complete Reading Electric Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Martindale Electric Co.
Mine Safety Appliances Co.—"COMFO, DUSTFOE, GASFOE"
Pulmosan Safety Equip. Co.
United States Rubber Co.
Willson Products Div., Ray-O-Vac Co.

RETAINERS, BEARING

Bearings, Inc.

RHEOSTATS

Allen-Bradley Co.
American Cyanamid Co., Explosives Dept.
Central Scientific Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div. Square D Co.
General Electric Co., Apparatus Sales Div.
Hercules Powder Co.
National Powder Co.
Westinghouse Electric Corp.

RIFFLE BUCKETS

Instrument Div., Gichner Inc.

RINGS, COLLECTOR, ARMATURE

Complete Reading Electric Co.
Superior Carbon Products, Inc.
West Virginia Armature Co.

RIPPERS, BULLDOZERS, FRONT-MOUNTED

H. & L. Tooth Co.

RIPPERS, CABLE-CONTROLLED

Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

RIPPERS, HYDRAULIC

Tractomotive Corp.

RIVER-LOADING PLANTS

Bartlett, C. O., & Snow Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

RIVETERS, PNEUMATIC

Cleco Div., Reed Roller Bit Co.

RIVETS

Bethlehem Steel Co.
Oliver Iron & Steel Corp.
Republic Steel Corp.—"REPUBLIC"

ROCK-DUST DISTRIBUTORS, DRY

American Mine Door Co.—"DUSTMASTER, MIGHTY MIDGIT"
Imperial-Cantrell Mfg. Co.—"JET"
Mine Safety Appliances Co.—"BANTAM," "BANTAM 400," "FACE DUSTER TYPE S"

ROCK-DUST DISTRIBUTORS, WET

American Mine Door Co.—"LITTLE CHIEF"
Mine Safety Appliances Co.—"BANTAM 400

RODS, LEVEL

Kennedy-Van Saun Mfg. & Engrg. Corp.
Kern Instruments, Inc.

ROLLERS, CAST-IRON

Webster Mfg. Co.

ROLLERS, ROAD

Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton
Blaw-Knox Co., Blaw-Knox Bldg.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"
Iowa Mfg. Co.

ROLLERS, SLOPE, CAST IRON, STEEL

C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
McLanahan & Stone Corp.
Sanford Day Iron Works, Inc.
Vulcan Iron Works

ROLLERS, SLOPE, WOOD

C. S. Card Iron Works
J. V. Hammond Co.
McLanahan & Stone Corp.

ROLLERS, TRACTOR-TRACK REPLACEMENT

Sterling Steel Casting Co.

ROOF ARCHES, STEEL

Arrowhead Steel Buildings, Inc.
Mining Progress, Inc.

ROOF BARS, ALUMINUM

Reynolds Metals Co.

ROOF BARS, ALUMINUM HINGED

Herold Mfg. Co.

ROOF BARS, STEEL

Herold Mfg. Co.
Mining Progress, Inc.
West Virginia Steel & Mfg. Co.

ROOF-BOLT HOLE GAGES

Ohio Brass Co.

ROOF-BOLT PULLERS, HYDRAULIC

Continental Gin Co., Industrial Div.

ROOF-BOLT TENSION INDICATORS

American Mine Supply Co.
Continental Gin Co., Industrial Div.
Herold Mfg. Co.
Snap-on Tools Corp.

ROOF BOLTS, EXPANSION-PLUG

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
The Elreco Corp.—"ELRECO"
Goodyear Tire & Rubber Co.
National Mine Service Co.
Oliver Iron & Steel Corp.
Pattin Mfg. Co.
Pittsburgh Screw & Bolt Corp.
Republic Steel Corp.—"REPUBLIC"
West Virginia Steel & Mfg. Co.
Youngstown Sheet & Tube Co.

ROOF BOLTS, MORTAR EMBEDMENT

Sika Chemical Corp.—"PERFO SYSTEM"

ROOF BOLTS, SQUARE HEAD

Sheffield Steel Div., Armco Steel Corp.

ROOF BOLTS, WEDGE-TYPE

Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
National Mine Service Co.
Oliver Iron & Steel Corp.
Pattin Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
West Virginia Steel & Mfg. Co.
Youngstown Sheet & Tube Co.

ROOF DRAINS

J. Z. Zurn Mfg. Co.—"ZURN"

ROOF RESURFACERS
Stonhard Co.

ROOF SUPPORTS
Herold Mfg. Co.

ROOF SUPPORTS, ALUMINUM
Reynolds Metals Co.

ROOF SUPPORTS, YIELDING ARCH
Bethlehem Steel Co.
Herold Mfg. Co.
Mining Progress, Inc.

ROOF VENTILATORS, POWER
American Blower Corp.

ROOFING, FLASHING, COPPER
Revere Copper & Brass Inc.

ROOFING, FLASHING NICKEL ALLOY
International Nickel Co., Inc.

ROOFING, FLASHING-ZINC
Illinois Zinc Co.

ROOFING, SIDING
Ruberoid Co.

ROOFING, SIDING, ALUMINUM
Aluminum Company of America
R. C. Mahon Co.
T. J. Moss Tie Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.

ROOFING, SIDING, ASBESTOS
Johns-Manville — "TRANSITE, FLEX-STONE, AQUADAM"
Keasbey & Mattison Co.
Philip Carey Mfg. Co.
Ruberoid Co.

ROOFING, SIDING, GALVANIZED
Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co.
R. C. Mahon Co.
T. J. Moss Tie Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
U. S. Steel Corp.

ROOFING, SIDING, ZINC
Illinois Zinc Co.

ROOTERS
LeTourneau-Westinghouse Co.

SAFETY EQUIPMENT
Mine Safety Appliances Co.

SAFETY BELTS
E. D. Bullard Co.—"MORENCI"
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY DISPLAYS, SIGNS
American Optical Co.
E. D. Bullard Co.
Elliott Service Co., Inc.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"M-S-A"

SAFETY FOOTGEAR, LEATHER
Hy-Test Safety Shoe Div., International Shoe Co.
Lehigh Safety Shoe Co., Inc.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY FOOTGEAR, RUBBER
Goodall Rubber Co.
Lehigh Safety Shoe Co., Inc.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY HEADGEAR
American Optical Co.
E. D. Bullard Co.—"HARDBOILED"
General Scientific Equipment Co.
Mine Safety Appliances Co.—"SKULLGARD," "COMFO CAP"
National Mine Service Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-HED"
Willson Products Div., Ray-O-Vac Co.

SAFETY HOOKS
American Hoist & Derrick Co.—"CROSBY, "LAUGHLIN"
E. D. Bullard Co.—"BULLARD-BURNHAM"
General Scientific Equipment Co.

SALT
International Salt Co., Inc.
Mine Safety Appliances Co.
Morton Salt Co.—"MORTON"

SALT, WITH RUST INHIBITOR
Diamond Crystal Salt Co.

SALT TABLETS
E. D. Bullard Co.
U. S. Safety Service Co.—"PEP-UP"

SAMPLERS, COAL
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Hoffman Brothers Drilling Co.
Robert Holmes & Bros., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.

SAMPLERS, COAL, AUTOMATIC
Colorado Iron Works—"VEZIN"
Denver Equipment Co.—"DECO"
Galigher Co.—"GEARY JENNINGS"
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
McNally-Pittsburg Mfg. Corp.
Sturtevant Mill Co.

SAND DRIERS
Barber-Greene Co.
J. D. Christian Engineers
Denver Equipment Co.
Eimco Corp.
Robert Holmes & Bros., Inc.
Indiana Foundry Co.—"SUTTON"
Iowa Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Pioneer Engineering Works

SAW BLADES
Gensco Tools Div., General Steel Warehouse Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Martindale Electric Co.
Simonds Saw & Steel Co.—"SI-CLONE"
Thor Power Tool Co.

SAWS, AIR
Ingersoll-Rand Co.

SAWS, BAND
Henry Disston Div.
Simonds Saw & Steel Co.

SAWS, CIRCULAR
Black & Decker Mfg. Co.
Henry Disston Div., H. K. Porter Co., Inc.
Mall Tool Co.—"MALL"
Martindale Electric Co.
Simonds Saw & Steel Co.

SAWS, HACK
Graybar Elec. Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Simonds Saw & Steel Co.
Snap-on Tools Corp.
Thor Power Tool Co.

SAWS, HAND
Gensco Tools Div., General Steel Warehouse Co., Inc.

SAWS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Homelite Div., Textron American, Inc.—"HOMELITE"
Homelite Div., Textron American, Inc.
Mall Tool Co.—"MALL"
Syntron Co.
Thor Power Tool Co.

SCALES, PORTABLE TRUCK
Winslow Government Standard Scale Works, Inc.

SAWS, POWER
Graybar Elec. Co., Inc.
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co.
Mall Tool Co.—"MALL"
Thor Power Tool Co.
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc.

SAWS, POWER, AIR
Ingersoll-Rand Co.

SCALE-WEIGHT RECORDERS
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America—"COX & STEVENS"
Fairbanks Morse Co.
Femco, Inc.
Howe Scale Co., Inc.
Koehring Co.
Streeter-Amet Co.
Taller & Cooper
Thurman Machine Co.
Toledo Scale Co.—"TOLEDO PRINT-WEIGH"
Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCALE-WEIGHT RECORDERS, CONVEYOR
Merrick Scale Mfg. Co.—"WEIGHTOMETER"

SCALES, MINE-CAR, TRUCK
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America—"COX & STEVENS"
Fairbanks Morse Co.
Femco, Inc.
L. B. Foster Co.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.—"TOLEDO PRINT-WEIGH"
Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCALES, R. R.
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America—"COX & STEVENS"
Fairbanks Morse Co.
L. B. Foster Co.
Morse Bros. Machinery Co.
Howe Scale Co., Inc.
Streeter-Amet Co.
Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCRAPER TIPS, TEETH
American Brake Shoe Co., Amsco Div.

SCRAPERS, DRAG
Caterpillar Tractor Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Laubenstein Mfg. Co.

Remaly Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sauerman Bros., Inc.—"CRESENT"

SCRAPERS, SELF-POWERED

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Euclid Division, General Motors Corp.
International Harvester Co., Construction Equipment Div.—"PAYSCRAPER"
Joy Mfg. Co.
LeTourneau-Westinghouse Co.—"TOURNA-PULL"
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

SCRAPERS, SHOT-HOLE

Leetonia Tool Co.

SCRAPERS, TRACTOR-POWERED

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.
Oliver Corp.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

SCRAPERS, UNDERGROUND

Eimco Corp.
Joy Mfg. Co.

SCREEN BARS

Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Link-Belt Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Salem-Brosius, Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.
Wedge Wire Corp.—"KLEENSLOT"

SCREEN CLOTH, WIRE

Bonded Scale & Machine Co.
Cambridge Wire Cloth
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
John Flocker & Co.
L. B. Foster Co.
Hewitt-Robins, Inc.—"GYRALOY, SUPER GYRALOY"
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Ludlow Saylor Wire Cloth Co.—"ARCH-CRIMP," "STA-SMOOTH," "STA-CLEAN," "STA-TRU," "REK-TANG," "LUDLOW," "SUPER-LOY," "PERFECT"
Newark Wire Cloth Co.
Pioneer Engineering Works
Simplicity Engineering Co.
W. S. Tyler Co.—"DOUBLE-CRIMP," "TON-CAP," "TY-ROD," "CORDUROY"

SCREEN-CLOTH HEATERS

Deister Concentrator Co.—"FLEXELEX"
F. R. Hannon & Sons—"HANCO"
Link-Belt Co.
Productive Equipment Corp.
Screen Equipment Co.
Simplicity Engineering Co.
W. S. Tyler Co.—"TY-ELECTRIC"

SCREEN PLATE, PERFORATED

Bonded Scale & Machine Co.
Chicago Perforating Co.
Diamond Mfg. Co.
John Flocker & Co.
Harrington & King Perforating Co., Inc.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Laubenstein Mfg. Co.
Link-Belt Co.
Pioneer Engineering Works
Remaly Mfg. Co.
Salem-Brosius, Inc.
W. J. Savage Co.
Simplicity Engineering Co.
Standard Stamping & Perf. Co.
Stephens-Adamson Mfg. Co.

SCREEN SECTIONS, REPLACEMENT

Cleveland Wire Cloth & Mfg. Co.

SCREENS, CENTRIFUGAL

Bird Machine Co.—"BIRD-HUMBOLDT"
Centrifugal & Mech. Industries, Inc.—"C-M-I"
John Flocker & Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Heyl & Patterson, Inc.—"RFINEVELD"
Laubenstein Mfg. Co.
Link-Belt Co.
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
Standard Stamping & Perf. Co.
W. S. Tyler Co.

SCREENS, DEWATERING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bartlett, C. O., & Snow Co.
Bird Machine Co.
Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Denver Equipment Co.—"DENVER"
Fairmont Machinery Co.
John Flocker & Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Laubenstein Mfg. Co.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Newark Wire Cloth Co.
The Nolan Co.
Nordberg Mfg. Co.—"SYMONS"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Screen Equipment Co.—"SECO"
Simplicity Engineering Co.
Smith Engineering Works—"TELSMITH"
Standard Stamping & Perf. Co.
W. S. Tyler Co.
Universal Road Machinery Co.
Wedge Wire Corp.—"KLEENSLOT"

SCREENS, REVOLVING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bartlett, C. O., & Snow Co.
Denver Equipment Co.—"DENVER"
John Flocker & Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co.
Lippmann Engrg. Works
McLanahan & Stone Corp.
Meckum Engr. Co.
Nordberg Mfg. Co.—"SYMONS"
Pioneer Engineering Works
W. J. Savage Co.
Smith Engineering Works—"TELSMITH"
Standard Stamping & Perf. Co.
Straub Mfg. Co., Inc.
W. S. Tyler Co.
Universal Engineering Co.
Universal Road Machinery Co.
Webster Mfg. Co.

SCREENS, ROD

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bixby-Zimmer Engineering Co.
John Flocker & Co.
Link-Belt Co.
Nordberg Mfg. Co.—"SYMONS"
W. S. Tyler Co.—"TY-LOC"

SCREENS, SHAKER

Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Central Scientific Co.
Diamond Mfg. Co.
Fairmont Machinery Co.
Fisher Scientific Co.
John Flocker & Co.
L. B. Foster Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Robert Holmes & Bros., Inc.
Industrial Engrg. & Construction Co., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Laubenstein Mfg. Co.
Link-Belt Co.
McLanahan & Stone Corp.
Newark Wire Cloth Co.
Pioneer Engineering Works
K. Prins & Associates
Remaly Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Standard Stamping & Perf. Co.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

SCREENS, TESTING

Commercial Testing & Engineering Co.

SCREENS, VIBRATING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Deister Concentrator Co. — "LEAHY HEAVY DUTY NO BLIND"
Deister Machine Co.
Denver Equipment Co.—"DENVER-DILLON"
Fairmont Machinery Co.
Fisher Scientific Co.
John Flocker & Co.
L. B. Foster Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.—"HI-G," "VIBREX," "ELIPTEX," "GYREX," "HI-SPEED," "HYDREX"
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Lecco Engrg. & Mfg. Co.—"LECCO-VIB"
Link-Belt Co.
Lippmann Engrg. Works
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
Ore Reclamation Co.
Pioneer Engineering Works — "SUPER SERVICE MESABI"

Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Remaly Mfg. Co.
Ridge Equipment Co.
Screen Equipment Co.—"SECO"
Simplicity Engineering Co.—"SIMPLI-FLO"
Smith Engineering Works—"TELSMITH"
Standard Stamping & Perf. Co.
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Sturtevant Mill Co.
Syntron Co.
W. S. Tyler Co.—"HUM-MER," "TY-ROCK," "TYLER-NIAGARA," "TY-ROCKET"
Universal Engineering Co.
Universal Vibrating Screen Co.—"UNIVERSAL," "UNILES," "UNIFLEX"
Williams Patent Crusher & Pulv. Co.

SCREENS, VIBRATING, TESTING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Denver Equipment Co.—"DENVER-DILLON"
Fisher Scientific Co.
John Flocker & Co.
Gilson Screen Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Lippmann Engrg. Works
Newark Wire Cloth Co.
Productive Equipment Corp.
Standard Stamping & Perf. Co.
Syntron Co.
W. S. Tyler Co.—"RO-TAP," "TY-LAB"
Universal Vibrating Screen Co.—"UNIVERSAL," "UNILES," "UNIFLEX," "UNIVIBLE"

SCREENS, WEDGE-WIRE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bixby-Zimmer Engineering Co.
John Flocker & Co.
Hendrick Mfg. Co.—"WEDGESLOT"
Wedge Wire Corp.—"KLEENSLOT"

SCREW WASHERS

McLanahan & Stone Corp.

SCREWS, CAP & SET

St. Louis Screw & Bolt Co.

SCREWS, SET

Leetonia Tool Co.

SCRUBBERS, AIR

Johnson-March Corp.—"TYPE A HYDRO-PRECIPITATOR"

SEALS, BEARING, GREASE & OIL

Bearings, Inc.
Garlock Packing Co.—"KLOZURES"
Greene, Tweed & Co.—"PALMETTO," "G-T-RINGS"
Johns-Manville—"CLIPPER"
United States Rubber Co.
West Virginia Armature Co.

SEALS, SHAFT, MECHANICAL

Anchor Packing Co.
Bearings, Inc.—"OITTO"
Byron Jackson Div., Borg-Warner Corp.
Garlock Packing Co.—"MECHANIPAK"
Greene, Tweed & Co.—"PALMETTO"
Koppers Co., Inc., Metal Products Div.
Syntron Co.
United States Rubber Co.

SECTIONALIZERS, AUTOMATIC RECLOSING

Electric Controller & Mfg. Co., Div. Square D Co.

SELF-RESCUERS

Mine Safety Appliances Co.

SEPARATORS, AIR

Hardinge Co., Inc.
I-T-E Circuit Breaker Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Majac Inc.
New Jersey Meter Co.—"DRIAIR"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.
Universal Road Machinery Co.
Williams Patent Crusher & Pulv. Co.

SHAFT HANGERS

Bartlett, C. O., & Snow Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.
W. J. Savage Co.
Transall, Inc.
Webster Mfg. Co.
Wilmot Engineering Co.

SHAFTING, STEEL

Bartlett, C. O., & Snow Co.
Bethlehem Steel Co.
Bonded Scale & Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Transall, Inc.
Bertrand P. Tracy Co.
West Virginia Armature Co.

SHAFTS, FLEXIBLE

Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Mall Tool Co.—"MALL"

SHAPES, STRUCTURAL, ALUMINUM

Aluminum Company of America
Robert Holmes & Bros., Inc.
Reynolds Metals Co.

SHEARS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

SHEAVES, HOISTING

American Brake Shoe Co., Amsco Div.
Bartlett, C. O., & Snow Co.
C. S. Card Iron Works
Robert Holmes & Bros., Inc.
McLanahan & Stone Corp.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Upson-Walton Co.
Vulcan Iron Works
Wilmot Engineering Co.

SHEAVES, TRACK

C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"

SHEAVES, V-BELT

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEXROPE"
The American Pulley Co.—"WEDG-TITE"
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Dayton Rubber Co.
Dodge Mfg. Corp.—"TAPER LOCK"
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.
Hewitt-Robins, Inc.—"JONES"
Iowa Mfg. Co.
Joy Mfg. Co.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
National Mine Service Co.
New York Belting & Packing Co.
Ore Reclamation Co.
Pittsburgh Gear Co.
Transall, Inc.
T. B. Woods Sons Co.
Worthington Corp.

SHEAVES, WIRE-ROPE

American Brake Shoe Co., Amsco Div.
C. S. Card Iron Works
L. B. Foster Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Meckum Engr. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Vulcan Iron Works—"ALLCASTEEL"
T. B. Woods Sons Co.

SHELVING, RACKS, ETC.

Frick-Gallagher Mfg. Co.
National Mine Service Co.

SHIM STOCK, SHIMS

Crucible Steel Co. of America
B. F. Goodrich Industrial Products Co.

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS

Continental Rubber Works
Dayton Rubber Co.—"METALASTIK"
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
New York Belting & Packing Co.—"GILMER SHOCK PADS"
United States Rubber Co.

SHOTFIRERS

American Mine Door Co.
Atlas Powder Co.
Femco, Inc.
King Powder Co., Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Olin-Mathieson Chemical Corp., Explosives Div.

SHOVELS, HAND

O. Ames Co.—"RED EDGE, MONOGAH, KNOXALL"
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
Salem Tool Co.
Wood Shovel & Tool Co.

SHOVELS, STANDARD POWER-TYPE, COAL LOADING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Eimco Corp.
L. B. Foster Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

SHOVELS, STRIPPING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Eimco Corp.
L. B. Foster Co.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Thew Shovel Co.—"LORAIN"

SHOVELS, TRACTOR

Allis-Chalmers Mfg. Co., Construction Machinery Div.

SHOWER-ROOM EQUIPMENT

Onox, Inc.—"ONOX FOOTMATS, ONOX SKIN-TOUGHENER"
J. Z. Zurn Mfg. Co.—"ZURN"

SIEVES, TESTING

Central Scientific Co.
Fisher Scientific Co.
Newark Wire Cloth Co.
W. S. Tyler Co.—"TYLER STANDARD"

SIGNALS, BELL & HORN

Graybar Elec. Co., Inc.
Taller & Cooper

SILOS, ASH, COAL & SAND STORAGE

Butler Mfg. Co.
Fairfield Engineering Co.
Marietta Concrete Corp.
Neff & Fry Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

SKIDS, MINE-CAR

Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Miners' Hardware Supply Co.
Sanford Day Iron Works, Inc.

SKIP WHEELS

American Brake Shoe Co., Amsco Div.

SKIPS, MINE-HOISTING

Connellsville Mfg. & Mine Supply Co.
Fairfield Engineering Co.
Hewitt-Robins, Inc.
Mayo Tunnel & Mine Equipment Co.
Nordberg Mfg. Co.
Vulcan Iron Works
Webster Mfg. Co.

SLIDE RULES

Central Scientific Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

SLINGS, BELT

C. R. Daniels Co.
B. F. Goodrich Co., Industrial Products Div.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Hewitt-Robins, Inc.
New York Belting & Packing Co.—"ROUGH RIDER"
Raybestos Manhattan, Inc., Manhattan Rubber Div.

SLINGS, CHAIN

American Chain & Cable Co., Inc.
John Flocker & Co.
Manning, Maxwell & Moore, Inc.—"TIPIT"
Pittsburgh Knife & Forge Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.

SLINGS, WOVEN WIRE

Cambridge Wire Cloth

SLINGS, WIRE-ROPE

American Chain & Cable—"ACCO REGISTERED," "DUALOC"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND," "B & B BROLOC"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Lug-All Co.—"LUG-ALL"
Leschen Wire Rope Co. Div., H. K. Porter Co.
Macwhyte Co.
National Mine Service Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Joseph T. Ryerson & Son, Inc.
Union Wire Rope Corp.—"TUFFY"
Upson-Walton Co.

SLUSHERS, SCRAPER

Joy Mfg. Co.

SNOW PLOWS

Walter Motor Truck Co.

SOLENOIDS

Allen-Bradley Co.
Cheatham Elec. Switching Device Co.
Complete Reading Electric Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co., Div., Square D Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
R. W. Nichols Co.—"MAC"
Trombetta Solenoid Corp.

SOLVENTS, CLEANING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.—"VARSOL"
Esso Standard Oil Co.
Fisher Scientific Co.
Martindale Electric Co.
Shell Oil Co.
Sinclair Refining Co.
Sun Oil Co.
Wyandotte Chemicals Corp.

SOUND PROTECTORS

American Optical Co.—"STRAIGHT-AWAY"

SPAD DRIVERS

American Mine Supply Co.

SPAD HANGERS

American Mine Supply Co.

SPADS

American Mine Supply Co.
Black Diamond Spad Co.—"BLACK DIAMOND"
Howells Mining Drill Co.—"HOWELLS"

SPECTACLES, SAFETY

American Optical Co.—"FUL-VUE ULTRASCOPIC"
E. D. Bullard Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"STYL-IZE"
Willson Products Div., Ray-O-Vac Co.

SPEED INCREASERS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
J. D. Christian Engineers
DeLaval Steam Turbine Co.
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Hewitt-Robins, Inc.—"JONES"
Link-Belt Co.
Philadelphia Gear Works
U. S. Electrical Motors, Inc.—"SYNCRO GEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI PITCH"
The American Pulley Co.—"SHAFT-KING"
Barber-Greene Co.
Bonded Scale & Machine Co.
J. D. Christian Engineers—"RITE LO SPEED"
Cleveland Worm & Gear Co.
Continental Gin Co., Industrial Div.
DeLaval Steam Turbine Co.
Dodge Mfg. Corp.—"TORQUE-ARM"
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Corp.—"HYGRADE," "LINE-O-POWER," "MAXIPOWER"
James Gear Mfg. Co., D. O.
Hewitt-Robins, Inc.—"JONES"
Link-Belt Co.
Master Electric Co.
R. W. Nichols Co.—"PNEU-TROL"
Ore Reclamation Co.
Philadelphia Gear Works—"MOTO REDUCER"
Square D Co.
Stephens-Adamson Mfg. Co.—"SACO"
Transall, Inc.
U. S. Electrical Motors, Inc.
West Virginia Electric Corp.
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS, WORM

Cone-Drive Gears Div., Michigan Tool Co.

SPIKES, TRACK—**See Rail Spikes**

SPIRALS, COAL

Western Machinery Co.—"WEMCO"

SPLICING COMPOUNDS, MATERIALS—**See Conveyor Belting Splicing Compounds**

SPRAY COMPOUNDS

Johnson-March Corp.—"COMPOUND MR"

SPRAY OILS

American Minechem Co.—"CHEMSPRAY"
Ashland Oil & Refining Co.—"ASHLAND PERMATREAT"
Cities Service Oil Co.
Esso Standard Oil Co.
Keenan Oil Co.—"KEENOIL 7"
Shell Oil Co.
Sinclair Refining Co.
Sun Oil Co.
The Texas Co.
Tide Water Associated Oil Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.

SPRAYING EQUIPMENT—**See also Dustproofing Equipment**

SPRAYING EQUIPMENT, OIL

Gray & Co., Inc.
Keenan Oil Co.
Sanford Day Iron Works, Inc.
W. J. Savage Co.

SPRAYING EQUIPMENT, WATER & COMPOUNDS

Gray & Co., Inc.
Johnson-March Corp.
Plastex Co.—"SWIRL SPRAY"

SPROCKETS

American Brake Shoe Co., Amsco Div.
Bonded Scale & Machine Co.

Browning Mfg. Co.
Chain Belt Co.
J. D. Christian Engineers
Continental Gin Co., Industrial Div.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER LOCK"
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel Co.
Link-Belt Co.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Mining Machine Parts, Inc.—"MANGALOR"
Morse Chain Co., A Borg-Warner Industry
Mosebach Electric & Supply Co.
National Mine Service Co.
Ore Reclamation Co.
Penn Machine Co.
W. J. Savage Co.
Taylor-Wharton Co. Div.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall, Inc.
Webster Mfg. Co.
Whitney Chain Co.
Wilmot Engineering Co.

SPROCKETS, CAST-IRON

Webster Mfg. Co.

SPROCKETS, COAL CUTTERS

Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Frank Prox Co., Inc.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Whitney Chain Co.

STACKERS, RECLAIMERS, COAL

Barber-Greene Co.
Dravo Corp.
Pioneer Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS

Blaw-Knox Co.
Dravo Corp.
General Scientific Equipment Co.
Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.
New York Belting & Packing Co.
Joseph T. Ryerson & Son, Inc.

STARTERS—See Motor Controllers, Starters

STARTERS, ENGINE, HYDRAULIC

Hydramotive, Inc.

STEEL, ABRASION-RESISTING

American Brake Shoe Co., Amsco Div.
American Steel & Wire Div., United States Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Sheffield Steel Div., Armco Steel Corp.
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Co. Div., Harsco Corp.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, ALLOY

American Brake Shoe Co., Amsco Div.
American Brake Shoe Co., Electro-Alloys Div.
American Steel & Wire Div., United States Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Meckum Engr. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Steel Div., Armco Steel Corp.
Simonds Saw & Steel Co.
Stulz-Sickles Co.
The Timken Roller Bearing Co.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, CARBON

American Steel & Wire Div., United States Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Electric Steel Foundry Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Meckum Engr. Co.
Phoenix Iron & Steel Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Steel Div., Armco Steel Corp.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, CORROSION

Allegheny Ludlum Steel Corp.
American Brake Shoe Co., Electro-Alloys Div.
Bethlehem Steel Co.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Steel Div., Armco Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, GALVANIZED

Inland Steel Co.

STEEL, HIGH-STRENGTH

American Steel & Wire Div., United States Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Steel Div., Armco Steel Corp.
Stulz-Sickles Co.
The Timken Roller Bearing Co.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, STAINLESS

Allegheny Ludlum Steel Corp.
American Steel & Wire Div., United States Steel Corp.
Crucible Steel Co of America—"REZISTAL"
Henry Disston Div., H. K. Porter Co., Inc.
Electric Steel Foundry Co.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC ENDUR"
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Simonds Saw & Steel Co.
U. S. Steel Corp.

STEEL, STRUCTURAL

Arrowhead Steel Buildings, Inc.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Bethlehem Steel Co.
Dayton Automatic Stoker Co.
Dravo Corp.
Robert Holmes & Bros., Inc.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
R. C. Mahon Co.
Meckum Engr. Co.
Phoenix Iron & Steel Co.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Sheffield Steel Div., Armco Steel Corp.
Thomas Engineering & Construction Co.
U. S. Steel Corp.
Vincennes Steel Corp.

STEEL, TOOL

Allegheny Ludlum Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America—"REX®"
Gardner-Denver Company
Jones & Laughlin Steel Corp.
Marathon Coal Bit Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Simonds Saw & Steel Co.
The Timken Roller Bearing Co.

STOKERS

Axeman-Anderson Co.—"ANTHRATUBE"

STOKERS, CHAIN-GRATE

Babcock & Wilcox Co.
Laclede Stoker Co.—"LACLEDE 'F' TYPE," "LACLEDE 'L' TYPE"
Combustion Engineering, Inc.

STOKERS, SPREADER

American Engineering Co.
Combustion Engineering, Inc.—"C-E"
Hoffman Combustion Engrg. Co.—"FIR-ITE"
Kennedy-Van Saun Mfg. & Engrg. Corp.
Laclede Stoker Co.—"LACLEDE-UNIVERSAL"

STOKERS, UNDERFEED

American Engineering Co.
Auburn Foundry, Inc., Heating Div.
Canton Stoker Corp.—"CANTON"
Carpenter Heating & Stoker Co.—"CARPENTER"
Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.

STOPERS, ROOF-BOLTING

Acme Machinery Co.
Gardner-Denver Company
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Penn Machine Co.
Schroeder Bros.
Thor Power Tool Co.

STOPPINGS, STEEL DEMOUNTABLE

Tri-County Building Service

STOVES, HEATING

Indiana Foundry Co.

STOVES, SAND DRYING

Indiana Foundry Co.
Goyne Pump Co.

STOWING MACHINES

Dravo Corp.
Herold Mfg. Co.

STRAINERS, PUMP

Barrett, Haentjens & Co.
S. P. Kinney Engineers, Inc.
Standard Stamping & Perf. Co.
J. Z. Zurn Mfg. Co.—"ZURN"

SUBSTATIONS, OUTDOOR

Allis-Chalmers Mfg. Co., Industrial Equipment Div.

Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

SUBSTATIONS, UNIT
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Square D Co.
Westinghouse Electric Corp.

SUGGESTION SYSTEMS, POSTERS, BOXES, FORMS
Elliott Service Co., Inc.

SUPERVISORY-CONTROL SYSTEMS
B-I-F Industries, Inc.—"SYNCHRO-SCAN"
The Bristol Co.—"METAMETER TELEMETERING"
Femco, Inc.
General Electric Co., Apparatus Sales Div.
Sperry Rand Corp., Remington Rand Div.

SUPERVISORY CONTROL SYSTEM
Elliott Service Co., Inc.—"MANAGEMENT INFORMATION"

SURVEYING EQUIPMENT
American Paulin System
C. L. Berger & Sons, Inc.—"BERGER"
Charles Bruning Co., Inc.
Brunson Instrument Co.
Copperweld Steel Co., Wire & Cable Div.
Geo-Optic Co., Inc.
Gurley, W. & L. E.
Keuffel & Esser Co.
Suverkrop Instruments
Wild Heerbrugg Instruments, Inc.

SWEATBANDS
Pulmosan Safety Equip. Co.

SWITCHBOARDS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Cutler-Hammer, Inc.
Femco, Inc.
General Electric Co., Apparatus Sales Div.
General Electric Co., Distribution Assemblies Dept.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ready Power Co.
Square D Co.
Taller & Cooper
Westinghouse Electric Corp.

SWITCH BOXES
Femco, Inc.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Westinghouse Electric Corp.

SWITCH HOUSES
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

SWITCH STANDS, RAILWAY
American Brake Shoe Co., Ramapo Ajax Div.

SWITCHERS, RR CAR
LeTourneau-Westinghouse Co.—"SWITCH MOBILE," "SWITCH-TRACTOR"

SWITCHES, CONVEYOR-CONTROL
Allen-Bradley Co.
Femco, Inc.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL
Allen-Bradley Co.
Arrow Hart & Hegeman Electric Co.
The Bryant Electric Co.
Cheatham Elec. Switching Device Co.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Delta-Star Electric Div., H. K. Porter Co., Inc.
Dooley Brothers
Electric Controller & Mfg. Co., Div. Square D Co.
The Elreco Corp.—"POWER"
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Construction Materials Dept.
General Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.
McGill Mfg. Co., Inc.—"LEVOLIER"
Mosebach Electric & Supply Co.
Nachod & U. S. Signal Co.
National Mine Service Co.
Shepard Niles Crane & Hoist Corp.
Square D Co.
Stackpole Carbon Co.
West Virginia Electric Corp.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL HIGH-VOLTAGE
Delta-Star Electric Div., H. K. Porter Co., Inc.

SWITCHES, ELECTRICAL, SAFETY
Arrow Hart & Hegeman Electric Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Dooley Brothers
General Electric Co., Apparatus Sales Div.
General Electric Co., Trumbull Electric Dept.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Shepard Niles Crane & Hoist Corp.
Square D Co.
Westinghouse Electric Corp.

SWITCHES, LOCOMOTIVE-TRANSFER
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Trumbull Electric Dept.
Jeffrey Mfg. Co.
Post Glover Electric Co.—"P-G"

SWITCHES, MERCURY
Arrow Hart & Hegeman Electric Co.
Complete Reading Electric Co.
Crouse-Hinds Co.
Durakool, Inc.
Femco, Inc.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Post Glover Electric Co.—"P-G"
Westinghouse Electric Corp.

SWITCHGEAR
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Distribution Assemblies Dept.
I-T-E Circuit Breaker Co.
Square D Co.
Westinghouse Electric Corp.

TABLE DECKS, WASHING
Linatex Corp. of America

TABLES, AIR-CLEANING
Fairmont Machinery Co.
Jeffrey Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"

TABLES, COAL-WASHING
Deister Concentrator Co.—SUPER DUTY DIAGONAL DECK"
Deister Machine Co.
Jeffrey Mfg. Co.
Link-Belt Co.

TACHOMETERS
The Bristol Co.—"BRISTOL'S"
Complete Reading Electric Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Schroeder Bros.
Taller & Cooper
Westinghouse Electric Corp.

TABLES, DRAFTING
Charles Bruning Co., Inc.

TAKEOFFS, POWER
Gar Wood Industries, Inc.
Goodman Mfg. Co.
Henrickson Mfg. Co.
Schroeder Bros.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Vickers, Inc., Tulsa Winch Div.—"TULSA®"

TAKEUPS, CONVEYOR
Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.
J. D. Christian Engineers
Goodman Mfg. Co.
Hewitt-Robins, Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

TAMPERS, BACKFILL
Cleco Div., Reed Roller Bit Co.

TAMPERS, SHOTHOLE
Atlas Powder Co.
Leetonia Tool Co.
Salem Tool Co.

TAMPING BAGS—See Bags, Tamping

TAMPING PLUGS
National Mine Service Co.
National Powder Co.

TAMPING STICKS, WOOD
Atlas Powder Co.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
J. V. Hammond Co.
National Mine Service Co.
National Powder Co.
Salem Tool Co.

TANKS, CLARIFYING, SLUDGE RECOVERY
Fairmont Machinery Co.
Denver Equipment Co.—"DENVER"
Eagle Iron Works
Peterson Filters & Engineering Co.

K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

TANKS, RUBBER-LINED

Denver Equipment Co.—"DENVER"
Galigher Co.
Gates Rubber Co.
B. F. Goodrich Co., Industrial Products Div.
Linatex Corp. of America
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

TANKS, STEEL

Bethlehem Steel Co.
Black, Sivalls & Bryson, Inc.
Blaw-Knox Co.
Butler Mfg. Co.
Denver Equipment Co.—"DENVER"
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
R. C. Mahon Co.
Phoenix Iron & Steel Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.

TANKS, WOOD

Black, Sivalls & Bryson, Inc.
Denver Equipment Co.—"DENVER"

TAPE, ADHESIVE

Johns-Manville

TAPE, ELECTRICAL, PLASTIC

Boston Woven Hose & Rubber Co.
Complete Reading Electric Co.
Continental Rubber Works
Cooke-Wilson Electric Supply Co.
Dayton Rubber Co.—"HOLEFAST"
John Flocker & Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Graybar Elec. Co., Inc.
Johns-Manville—"JOMANCO"
Minnesota Mining & Mfg. Co.—"SCOTCH NO. 33, 22, 21 & 20"
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co.—"PLYMOUTH"
United States Rubber Co.

TAPE, FRICTION

Boston Woven Hose & Rubber Co.
Complete Reading Electric Co.
Continental Rubber Works
Cooke-Wilson Electric Supply Co.
Dayton Rubber Co.—"HOLEFAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Jenkins Bros.
Johns-Manville
Mosebach Electric & Supply Co.
National Electric Coil Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL"
Okonite Co.
Plymouth Rubber Co.—"SLIPKNOT"
Quaker Rubber Div., H. K. Porter Co., Inc.
Ruberoid Co.
United States Rubber Co.
West Virginia Armature Co.

TAPE, GLASS-CLOTH

Complete Reading Electric Co.
Graybar Elec. Co., Inc.
Johns-Manville
Minnesota Mining & Mfg. Co.—"SCOTCH NO. 27"
Minnesota Mining & Mfg. Co., Irvington Div.
National Electric Coil Co.

TAPE, PAPER

Minnesota Mining & Mfg. Co.—"SCOTCH"

TAPE, RUBBER

Boston Woven Hose & Rubber Co.
Complete Reading Electric Co.
Continental Rubber Works
Dayton Rubber Co.—"HOLEFAST"
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Co.
Graybar Elec. Co., Inc.
Jenkins Bros.
Johns-Manville
Mosebach Electric & Supply Co.
National Electric Coil Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL"
Okonite Co.
Plymouth Rubber Co.—"P. R."
Quaker Rubber Div., H. K. Porter Co., Inc.
United States Rubber Co.
West Virginia Armature Co.

TAPE, THERMOSETTING

Minnesota Mining & Mfg. Co.—"SCOTCH"

TAPE, VARNISHED-CAMBRIC

Complete Reading Electric Co.
Graybar Elec. Co., Inc.
Minnesota Mining & Mfg. Co.—"IRVINGTON," "IRV-O-FLATSEME," "IVI-BIND"
Minnesota Mining & Mfg. Co., Irvington Div.
National Electric Coil Co.

TAPE, VULCANIZING

American Mine Door Co.

TAPES, MEASURING

Charles Bruning Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Graybar Elec. Co., Inc.
Keuffel & Esser Co.
Lufkin Rule Co.

TAPS, CABLE & TROLLEY, FUSED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.—"MMP JAB-CO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TARPAULINS

Bemis Bro. Bag Co.—"DRI-TITE"

TELEPHONES, BATTERY

Crouse-Hinds Co.
Graybar Elec. Co., Inc.

TELEPHONES, SOUND-POWERED

Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Mining Progress, Inc.

TELEPHONES, TROLLEY

Femco, Inc.
Mine Safety Appliances Co.—"MINE-PHONE"

TELEVISION SYSTEMS

Diamond Power Specialty Co.—"UTILI-SCOPE," "UTILIVUE"
Femco, Inc.—"DAGE T. V."
Graybar Elec. Co., Inc.
Motorola Communications & Electronics, Inc.

TEMPERATURE INDICATORS, CONTROLLERS

B-I-F Industries, Inc.—"CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.—"GARDSMAN-VERI-TELL"
Westinghouse Electric Corp.

TERMINATORS

Delta-Star Electric Div., H. K. Porter Co., Inc.

TEST STANDS, HYDRAULIC

Fischer & Porter Co.
Schroeder Bros.—"UNIVERSAL"
Vickers, Inc., Div. Sperry Rand Corp.

TESTERS, CARBON MONOXIDE

Mine Safety Appliances Co.

TESTERS, INSULATION

Complete Reading Electric Co.
Electrical Distributors Co.
Martindale Electric Co.
Ideal Industries, Inc.

TESTERS, INSULATORS

I-T-E Circuit Breaker Co.

TESTERS, PORTABLE HYDRAULIC

Schroeder Bros.—"PT-50-B"

TESTERS, RAIL-BOND

Mosebach Electric & Supply Co.
Ohio Brass Co.

TESTERS, VOLTAGE

Complete Reading Electric Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
I-T-E Circuit Breaker Co.
Ideal Industries, Inc.
Martindale Electric Co.
Square D Co.
Westinghouse Electric Corp.

THEODOLITES, OPTICAL, MINING

Kern Instruments, Inc.

THERMOCOUPLES

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.

THREADING MACHINES, PIPE & BOLT

Beaver Pipe Tools, Inc.

THREADING TOOLS, PIPE

Beaver Pipe Tools, Inc.

THROTTLE CONTROLS

Link-Belt Speeder Corp.—"Speed-o-trol"

THICKENERS

American Well Works
Denver Equipment Co.—"DENVER-STANDARD," "DENVER HEAVY-DUTY AUTOMATIC"
Dorr-Oliver, Inc.
Eimco Corp.
Hardinge Co., Inc.
Link-Belt Co.
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

TIE REMOVERS, REPLACERS

Gibraltar Equipment & Mfg. Co.

TIMBER—See also Roof Bars, Arches, Supports

TIMBER, ALUMINUM

Reynolds Metals Co.

TIMBER, TREATED

Koppers Co., Inc., Wood Preserving Div.—"WOLMANIZED"
T. J. Moss Tie Co.
Republic Creosoting Co.

TIMBER, YIELDING STEEL PROPS

Mining Progress, Inc.
T. J. Moss Tie Co.

TIMBER FRAMERS

Denver Equipment Co.—"DENVER"
Stearns-Roger Mfg. Co.

TIMBER PULLERS

Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

TIMBER-TREATING MATERIALS

Carbolineum Wood Preserving Co.—"CARBOLINEUM"
Darworth, Inc., Cuprinol Div.—"CUPRINOL"
The Dow Chemical Co.
Monsanto Chemical Co., Organic Chemicals Div.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS, OSMOPLASTIC, M-T-M"

TIMBERING MACHINES

Goodman Mfg. Co.
Ruger Equipment, Inc.—"RUGER TIMBERLIFT"

TIMERS, MERCURY

Durakool, Inc.
Joy Mfg. Co.
Mitchell Industrial Tire, Inc.—"MITCO TROUBLE FREE"

TIRE RECAPPING

Carolina Tire Co.

TIRES, RUBBER

Carolina Tire Co.
Dayton Rubber Co.—"THOROBRED"
Firestone Tire & Rubber Co.
Gates Rubber Co.
General Tire & Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co., Industrial Prods. Div.
Phillips Petroleum Co.
Seiberling Rubber Co.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.—"MITCO INDUSTRIAL"

TIRES, STEEL

National Mine Service Co.
Bertrand P. Tracy Co.

TOOLS, DRILLING

Stardrill-Keystone Co.

TOOLS, ELECTRICAL-CONNECTOR

Burndy Engrg. Co., Inc.—"HYTOOLS, HYPRESSES"
Erico Products, Inc.—"CADWELD"
Graybar Elec. Co., Inc.
Joy Mfg. Co.

TOOLS, MECHANICS

Ampco Metal, Inc.—"AMPCO SAFETY"
Bearings, Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Gensco Tools Div., General Steel Warehouse Co., Inc.
Graybar Elec. Co., Inc.
Snap-on Tools Corp.

TOOLS, PORTABLE, AIR

Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Ensign Electric & Mfg. Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co.—"MALL"
Marathon Coal Bit Co.
Penn Machine Co.
Schramm, Inc.
Schroeder Bros.
Snap-on Tools Corp.
Thor Power Tool Co.
Worthington Corp.

TOOLS, PORTABLE, ELECTRICAL

Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Ingersoll-Rand Co.
Mall Tool Co.
Martindale Electric Co.
Penn Machine Co.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Syntron Co.
Thor Power Tool Co.

TOOLS, POWDER-POWERED

Mine Safety Appliances Co.—"VELOCITY-POWER"
Remington Arms Co., Inc.—"REMINGTON INDUSTRIAL GUN," "REMINGTON STUD DRIVER"

TOOLS, TRACK

Aldon Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Leetonia Tool Co.
Mall Tool Co.—"MALL"

TORQUE CONVERTERS

Clark Equip. Co., Automotive Div. — "CLARK-TORCON"
National Supply Company—"NATIONAL"
Twin Disc Clutch Co.

TORQUE DIVIDERS

Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TORQUE WRENCHES

Bearings, Inc.
Ingersoll-Rand Co.
Marathon Coal Bit Co.
Snap-on Tools Corp.

TOWBOATS

Marietta Mfg. Co.

TOWERS, BARGE-UNLOADING

Clyde Iron Works, Inc.
Dravo Corp.
Heyl & Patterson, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

TOWERS, HYDRAULIC

Mobile Aerial Towers, Inc.—"HI-RANGER"

TRACK CLEANERS

American Mine Door Co.—"CANTON"

TRACK SHOES, POWER SHOVEL

American Steel Foundries—"WEARPACT"

TRACTOR-COMPRESSOR UNITS

Gardner-Denver Company
Le Roi Div., Westinghouse Air Brake Co.—"TRACTAIR"

TRACTOR GROUSER BARS

American Brake Shoe Co., Amsco Div.

TRACTOR GROUSERS

American Steel Foundries—"WEARPACT"

TRACTOR POWER CONTROL UNITS

LeTourneau-Westinghouse Co.

TRACTORS, CRAWLER

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Tractor Corp.—"TERRATRAC"
Caterpillar Tractor Co.
Diesel Energy Corp.
Eimco Corp.
Euclid Division, General Motors Corp.
International Harvester Co., Construction Equipment Div.
Oliver Corp.—"OLIVER"

TRACTORS, CRAWLER, UNDERGROUND

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Eimco Corp.
Goodman Mfg. Co.
International Harvester Co., Construction Equipment Div.
Joy Mfg. Co.

TRACTORS, RUBBER-TIRED MINE

Baker-Raulang Co.
Kersey Mfg. Co., Inc.

TRACTORS, TRUCK HAULAGE

Dart Truck Co.
Euclid Division, General Motors Corp.
Federal Motor Truck Co. Div., Napco Industries, Inc.
Four Wheel Drive Auto Co.
Henrickson Mfg. Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Mack Trucks, Inc.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.

TRACTORS, WHEELED

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Diesel Energy Corp.
The Frank G. Hough Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR TWIN C"
Minneapolis-Moline Co.
Oliver Corp.—"OLIVER"
Walter Motor Truck Co.

TRAILER AXLES

Clark Equip. Co., Automotive Div. — "CLARK"
Henrickson Mfg. Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Winter-Weiss Co.

TRAILER BODIES

Anthony Co.
Baughman Mfg. Co., Inc.
Perfection Steel Body Co.
Winter-Weiss Co.

TRAILERS, FULL

Fruehauf Trailer Co.

TRAILERS, FULL, BOTTOM-DUMP

Athey Products Corp.
Dart Truck Co.
Euclid Division, General Motors Corp.
Perfection Steel Body Co.
Sanford Day Iron Works, Inc.
Truck Engineering Co.

TRAILERS, FULL, SIDE-DUMP

Athey Products Corp.
Dart Truck Co.
Easton Car & Construction Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, FULL, REAR-DUMP

Athey Products Corp.
Easton Car & Construction Co.
Euclid Division, General Motors Corp.
Hercules Steel Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI

Fruehauf Trailer Co.

TRAILERS, SEMI, BOTTOM-DUMP

Dart Truck Co.
The Heil Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI, SIDE-DUMP

Baughman Mfg. Co., Inc.
Easton Car & Construction Co.
Hockensmith Corp.
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI, REAR-DUMP

Anthony Co.
Easton Car & Construction Co.
The Heil Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRANSFER CASES

Clark Equip. Co., Automobile Div.
Four Wheel Drive Auto Co.
Jeffrey Mfg. Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRANSFORMERS, CONTROL, INSTRUMENT

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Bristol Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSFORMERS, POWER

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Kuhlman Elec. Co.
Moloney Electric Co.—HYPERCORE"
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Wagner Electric Corp.
West Virginia Electric Corp.
Westinghouse Electric Corp.

TRANSITS, ENGINEER'S

Suverkrop Instruments

TRANSMISSIONS, AUTOMOTIVE

Allison Div., General Motors Corp. — "TORQMATIC"
Clark Equip. Co., Automotive Div. — "CLARK"
Four Wheel Drive Auto Co.
Fuller Mfg. Co.
Westinghouse Electric Corp.

TRANSMISSIONS, REVERSING

The Snow-Nabstedt Gear Corp.

TRANSMISSIONS, VARIABLE SPEED

Reliance Electric & Engineering Co., Reeves Pulley Co. Div.

TRIP LAMPS

Concordia Electric Co.—"CEAG"
The Elreco Corp.—"ELRECO"
General Electric Co., Lamp Div.
National Mine Service Co.

TROLLEY CLAMPS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY, CONVEYOR

Link-Belt Co.

TROLLEY FROGS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY FROGS, ELECTRIC

Cheatham Elec. Switching Device Co.
Ohio Brass Co.

TROLLEY GUARDS

Ensign Electric & Mfg. Co.
John Flocker & Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.—"VISI-GARD"
Mosebach Electric & Supply Co.
National Mine Service Co.
Mine Safety Appliances Co.
Ohio Brass Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

TROLLEY HANGERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY HARPS, SHOES, SLIDERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.
West Virginia Armature Co.

TROLLEY POLES, STEEL

Jeffrey Mfg. Co.

TROLLEY POLES, WOOD

Duquesne Mine Supply Co.
Flood City Brass & Electric Co.
J. V. Hammond Co.

TROLLEY-SHOE CONTACTORS

American Mine Door Co.
Cheatham Elec. Switching Device Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Nachod & U. S. Signal Co.
Ohio Brass Co.
Ohio Carbon Co.

TROLLEY SIGNALS SYSTEMS

American Mine Door Co.
Link-Belt Co.

TROLLEY SPLICES

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY SYSTEMS

The Elreco Corp.—"ELRECO"
Ohio Brass Co.

TROLLEY TAPS—See Taps, Trolley & Cable

TROLLEY WHEELS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.
Pittsburgh Gear Co.

TROLLEYS, I-BEAM

Coffing Hoist Div., Duff-Norton Co.

TRUCK AXLES

Eaton Mfg. Co., Axle Div.
Ford Motor Co.
Four Wheel Drive Auto Co.
Henrickson Mfg. Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRUCK AXLES, DRIVING

Ford Motor Co.
Four Wheel Drive Auto Co.
Henrickson Mfg. Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRUCK BODIES

Anthony Co.
Baughman Mfg. Co., Inc.
Easton Car & Construction Co.
Ford Motor Co.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
The Heil Co.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marmon-Herrington Co., Inc.
Perfection Steel Body Co.
Truck Engineering Co.

TRUCK BODY FLOORS, ALUMINUM

Revere Copper & Brass, Inc.

TRUCK BOGIES

Clark Equip. Co., Automotive Div. — "CLARK"
Ford Motor Co.
Four Wheel Drive Auto Co.
Henrickson Mfg. Co.

TRUCK DRIVES, TANDEM-AXLE

Clark Equip. Co., Automotive Div. — "CLARK"
Eaton Mfg. Co., Axle Div.
Ford Motor Co.
Henrickson Mfg. Co.
Marmon-Herrington Co., Inc.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRUCK DUMP HOISTS ELECTRIC, OVERHEAD

Easton Car & Construction Co.

TRUCK SAFETY STEPS

E. D. Bullard Co.

TRUCKS, AUTOMOTIVE

Chevrolet Motor Div.
Dart Truck Co.

Dodge Div., Chrysler Corp.—"DODGE 'JOB RATED' "
Euclid Division, General Motors Corp.
Federal Motor Truck Co. Div., Napco Industries, Inc.
Ford Motor Co.
Four Wheel Drive Auto Co.
Henrickson Mfg. Co.
International Harvester Co., Construction Equipment Div.—"PAYHAULER"
International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
Koehring Co.
Mack Trucks, Inc.
Marmon-Herrington Co., Inc.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.

TRUCKS, FORK LIFT
Hyster Co.—"HYSTER"

TRUCKS, MINE-CAR
American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
National Malleable & Steel Castings Co.—"NATIONAL NC-1"
Sanford Day Iron Works, Inc.

TRUCKS, MINE-LOCOMOTIVE
Penn Machine Co.

TRUCKS, OFF-HIGHWAY
Euclid Div., General Motors Corp.

TUBING
Flexible Tubing Co.

TUBING, ELECTRICAL MECHANICAL
Youngstown Sheet & Tube Co.

TUBING, FLEXIBLE-METAL
Cobra Metal Hose, Div., DK Mfg. Co.

TUBING, PLASTIC
Minnesota Mining & Mfg. Co., Irvington Div.

TUBING, STAINLESS-STEEL
National Tube Div., United States Steel Corp.—"USS SHELBY"

TURNBUCKLES
American Hoist & Derrick Co.—"CROSBY", "LAUGHLIN"
Bethlehem Steel Co.
Duquesne Mine Supply Co.
Ohio Brass Co.
Joseph T. Ryerson & Son, Inc.
St. Louis Screw & Bolt Co.
Upson-Walton Co.

TURNBUCKLES, INSULATED
The Elreco Corp.

TURNERS, WHEEL-FLANGE & TREAD
Transall, Inc.

VACUUM CLEANING, SWEEPING EQUIPMENT
Black & Decker Mfg. Co.
Ideal Industries, Inc.
Martindale Electric Co.
Mechanical Industries, Inc.
U. S. Hoffman Machinery Corp., Industrial Div.

VALVE ACTUATORS, CYLINDER
Ledeen Mfg. Co.

VALVE REFACERS & GRINDERS
Black & Decker Mfg. Co.

VALVES, ANGLE & Y
The Duriron Co., Inc.
Electric Steel Foundry Co.
Fairbanks Co.
Farris Flexible Valve Corp.—"XV DIAPHRAGM SEAL"
Homestead Valve Mfg. Co.
Jeffrey Mfg. Co.
Midland Pipe & Supply Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, AUTOMATIC FULL FLOW QUICK OPENING AND SHUTOFF
Coppus Engineering Corp.—"SENTRY"

VALVES, AIR
Lunkenheimer Co.

VALVES, BUTTERFLY
S. P. Kinney Engineers, Inc.

VALVES, CHECK
Allen-Sherman-Hoff Pump Co.—"FLEX-CHECK", "RUBBER LINED"
Barrett, Haentjens & Co.
Crane Co.
Electric Steel Foundry Co.
Fairbanks Co.
Farris Flexible Valve Corp. — "FLEX VALVE"
Goyne Pump Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
Lunkenheimer Co.
Midland Pipe & Supply Co.
R. W. Nichols Co.—"PNEU-TROL"
Ohio Brass Co.
Osmose Wood Preserving Co.—"TECHNO-CHECK"
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Bros.
Vickers, Inc., Div. Sperry Rand Corp.
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, COMPRESSED-AIR
A. W. Cash Valve Mfg. Corp.
Clark Controller Co.
Cleco Div., Reed Roller Bit Co.
Fairbanks Co.
Homestead Valve Mfg. Co.
Hose Accessories Co.
C. B. Hunt & Son, Inc.—"QUICK-AS-WINK"
Jenkins Bros.
R. W. Nichols Co.—"MAC"
Pennsylvania Pump & Compressor Co.—"AIRCHECK", "GASCHEK"
Schroeder Bros.
Square D Co.
Walworth Co.

VALVES, CORROSION-RESISTANT
Electric Steel Foundry Co.

VALVES, DIAPHRAGM
Black, Sivalls & Bryson, Inc.
The Bristol Co.—"SYNCHRO-VALVES"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
The Duriron Co., Inc.
Farris Flexible Valve Corp.
Fischer & Porter Co.
Foxboro Co.
Grinnell Co., Inc.—"GRINNELL-SAUNDERS"
Minneapolis-Honeywell Regulator Co., Industrial Division
Square D Co.
Tube Turns Plastics, Inc.—"PVC", "TUBE TURNS"

J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, FLOAT
Black, Sivalls & Bryson, Inc.
Fischer & Porter Co.
Square D Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, FOOT
Branford Co.—"BRANFORD"
Crane Co.
Flood City Brass & Electric Co.
Ledeen Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
Midland Pipe & Supply Co.
Walworth Co.

VALVES, GATE
American Brake Shoe Co., National Bearing Div.
Crane Co.
Electric Steel Foundry Co.
Fairbanks Co.
Fischer & Porter Co.
Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
Lunkenheimer Co.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Stephens-Adamson Mfg. Co.—"TWISTITE"
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.
Worthington Corp.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, GLOBE
Crane Co.
Electric Steel Foundry Co.
Fairbanks Co.
Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, MOTOR-OPERATED
Black, Sivalls & Bryson, Inc.
The Bristol Co.
Convair
Electric Steel Foundry Co.
Farris Flexible Valve Corp.
Fischer & Porter Co.
Foxboro Co.
Homestead Valve Mfg. Co.
Kennedy Valve Mfg. Co.
S. P. Kinney Engineers, Inc.
Ludlow Valve Mfg. Co., Inc.
Midland Pipe & Supply Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Philadelphia Gear Works—"LIMITORQUE"
R-P & C Valve Div., American Chain & Cable Co., Inc.
Rockwell Mfg. Co.—"ROCKWELL"
Walworth Co.
Western Precipitation Corp.—"TYPE R-1", "FLOATING-SEAL"
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, NEEDLE
Fairbanks Co.
Midland Pipe & Supply Co.
R. W. Nichols Co.—"PNEU-TROL GENERANT"
Ohio Brass Co.

R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Bros.
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.

VALVES, PINCH
Farris Flexible Valve Corp.
Linatex Corp. of America
Red Jacket Co., Inc.—"RED JACKET"

VALVES, PLASTIC
Lunkenheimer Co.—"LUNCOR"

VALVES, PLUG
Ampco Metal, Inc.
American Car & Foundry Div., ACF Industries, Inc.
Barrett, Haentjens & Co.
Convair
The Duriron Co., Inc.
Homestead Valve Mfg. Co.
S. P. Kinney Engineers, Inc.
Ludlow Valve Mfg. Co., Inc.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Rockwell Mfg. Co. — "ROCKWELL," "NORDSTROM"
Tube Turns Plastics, Inc.—"PVC," "TUBE TURNS"
Walworth Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, POWER-OPERATED
Ledeen Mfg. Co.

VALVES, PUMP
American Brake Shoe Co., Denison Eng'g Co. (Sub.)
Anchor Packing Co.
Electric Steel Foundry Co.
New York Belting & Packing Co.—"N Y B & P," "GREAT SEAL"
Walworth Co.

VALVES, SAFETY
Black, Sivalls & Bryson, Inc.
A. W. Cash Valve Mfg. Corp.
D. T. Williams Valve Co., Div. The Schaible Co.

VALVES, STAINLESS-STEEL
Electric Steel Foundry Co.

VALVES, UNLOADING
R. Conrader Co.—"CONRADER"

VARNISHES, INSULATING
Chemical Materials Dept., General Electric Co.
Complete Reading Electric Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Jeffrey Mfg. Co.
Martindale Electric Co.
Minnesota Mining & Mfg. Co.—"IRVINGTON & HARVEL"
Minnesota Mining & Mfg. Co., Irvington Div.
National Mine Service Co.
Pennsylvania Electric Coil Corp.

VENTILATING, TUBING
American Brattice Cloth Corp.
Bemis Bro. Bag Co.—"FLEXIPIPE"
Coppus Engineering Corp.
E. I. du Pont de Nemours & Co., Inc., Fabrics Div.—"VENTUBE"
Flexaust Co.—"PORTOVENT"
Goodrich Co., B. F., Industrial Products Div.
Jeffrey Mfg. Co.

VIBRATION ABSORBERS
Cobra Metal Hose, Div. DK Mfg. Co.

VIBRATION DAMPERS, RUBBER
Goodyear Tire & Rubber Co., Industrial Prods. Div.

VIBRATION MEASUREMENT, BLASTING
W. F. Sprengnether Instrument Co., Inc.

VIBRATORS, BIN & HOPPER
Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Manufacturing Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Martin Engrg. Co.
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.—"TY-SPEED"

VIBRATORS, CHUTE
Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Martin Engrg. Co.—"VIBROLATOR"
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.

VOLTMETERS, INDICATING
Complete Reading Electric Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Martindale Electric Co.
Westinghouse Electric Corp.

VOLTMETERS, RECORDING
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

WAGONS, HAULING
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Euclid Division, General Motors Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

WALKWAYS, STRUCTURAL
Black, Sivalls & Bryson, Inc.

WALLS, SUSPENDED FURNACE
Bigelow-Liptak Corp.

WARNING SIGNALS
American Mine Door Co.
Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Nachod & U. S. Signal Co.

WASHABILITY TESTS
The Daniels Co. Contractors, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Warner Laboratories

WASHERS, AIR
American Blower Corp.

WASHERS, CALCIUM-CHLORIDE
Fuel Process Co.
Kanawha Mfg. Co.

WASHERS, HEAVY-MEDIA
The Daniels Co. Contractors, Inc.
Nelson L. Davis Co.
Fairmont Machinery Co.
Fuel Process Co.
Hewitt-Robins, Inc.—"ELIPTEX"
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.—"McNALLY TROMP"
The Ore & Chemical Corp.—"OCC VESSEL"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

WASHERS, JIG
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
McNally-Pittsburg Mfg. Corp.—"McNALLY MOGUL," "McNALLY NORTON"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WASHERS, LAUNDER, TROUGH
Link-Belt Co.
K. Prins & Associates—"PRINS"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WASHERS, SAND-FLOTATION
Fairmont Machinery Co.
Jeffrey Mfg. Co.
United Engineers & Constructors, Inc.
Universal Road Machinery Co.

WASHERS, SCREW
McLanahan & Stone Corp.
Eagle Iron Works

WASHERS, UPWARD-CURRENT
Robert A. Cummings, Jr., & Associates
Eagle Iron Works
Fuel Process Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WASHERS, STEEL
St. Louis Screw & Bolt Co.

WATER NEUTRALIZERS
American Minechem Co.
American Well Works
E. I. du Pont de Nemours & Co., Inc.
Permutit Co.
Water Neutralizing Co.

WATER-RECLAMATION SYSTEMS
Bird Machine Co.
Bulkley, Dunton Processes, Inc.
Dorr-Oliver, Inc.
Kanawha Mfg. Co.
Permutit Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

WATER REPELLENTS
American Minechem Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Sika Chemical Corp.
Stonhard* Co.—"STONTITE," "STONSEAL"

WATER SYSTEMS, DOMESTIC
Barnes Mfg. Co.

WATER-TREATMENT EQUIPMENT
B-I-F Industries, Inc.

WEARING PLATES
American Brake Shoe Co., Amsco Div.

WEDGE BARS, TOOTH REPOINTING
American Brake Shoe Co., Amsco Div.
Kensington Steel Co.
Stulz-Sickles Co.—"MANGANAL"

WEDGES, CONE
Leetonia Tool Co.

WELDERS, ARC
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Caterpillar Tractor Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.
Hobart Bros. Co.

Lincoln Electric Co.—"SHIELD-ARC," "IDEAL-ARC," "FLEETWELDER," "LINEWELDER," "LINCOLNWELD"
Marathon Coal Bit Co.
Metal & Thermit Corp.—"M & T"
Mosebach Electric & Supply Co.
Penn Machine Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

WELDERS, RAIL BONDING

Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"GUYAN"
Ohio Brass Co.
Penn Machine Co.
Post Glover Electric Co.—"P-G"
Westinghouse Electric Corp.

WELDING CABLE

Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Electrical Wire & Cable Dept., United States Rubber Co.—"U. S. ROYAL"
Gar Wood Industries, Inc.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Guyan Machy. Co.
Hobart Bros. Co.
Lincoln Electric Co.—"STABLE-ARC," "LINCOLNDUCTOR"
Marathon Coal Bit Co.
National Electric Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.
Tweco Products, Inc.—"TWECO LITE"
Victor Equipment Co.
Westinghouse Electric Corp.

WELDING CARBON PRODUCTS

Harnischfeger Corp.
Helwig Co.
Marathon Coal Bit Co.
National Carbon Co., Div. of Union Carbide & Carbon Corp.
Ohio Carbon Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

WELDING, CUTTING TORCHES, OUTFITS

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
General Scientific Equipment Co.
Marathon Coal Bit Co.
Victor Equipment Co.

WELDING-ELECTRODE HOLDERS

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Erico Products, Inc.—"CADDY"
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co.—"COALTONG"
Marathon Coal Bit Co.
Mosebach Electric & Supply Co.
A. O. Smith Co.
Tweco Products, Inc.—"TWECOTONG"
West Virginia Armature Co.
Westinghouse Electric Corp.

WELDING ELECTRODES

Alloy Rods Co.—"ATOM ARC," "ARCALOG," "ARMORARC," "WEARARC," "WEAR FLAME," "TOOLARC," "NICKEL ARC," "BRONZE ARC," "BRONZE FLAME"
Ampco Metal, Inc.—"AMPCO TRODE," "PHAS-TRODE," "MANG-TRODE," "AMPCO-BREZ"
Crucible Steel Co. of America—"REZISTAL®," "STAINLESS"
Eutectic Welding Alloys Corp.—"BRONZOCHROM," "CASTOLIN EUTECTIC," "CUT TRODE," "EUTECHROM," "EUTEC-ROD," "EUTECTIC 'LOW' TEMPERATURE," EUTEC STAINROD," "EUTEC BRAZE," "FLOTECTIC," "FRIGID ARC," "EUTEC HANDOMATIC," "STEEL TECTIE," "TIN WELD," "WELDING ALLOYS," "EUTECTOR FLUX," "EUTECTRODE," "EUTECTO MASK," "EUTEC ALUM WELD," "EUTEC SILVER WELD," "EUTEC STAINTRODE," "ALU TIN," "AUTO CHEMIC," "CHAMFER TRODE," "COP WELD," "SIL WELD," "LOW AMP," "LOW TEMP," "NI TECTIC," "UNIMATIC," "XYRON"
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co. — "JETWELD," "FLEETWELD," "SHIELD-ARC," "STAINWELD," "ALUMINUMWELD," "AERISWELD," "FERRO-WELD," "SUFTWELD"
Marathon Coal Bit Co.
Metal & Thermit Corp.—"MUREX"
Mosebach Electric & Supply Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Revere Copper & Brass, Inc.
A. O. Smith Co.
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Co. Div., Harsco Corp.
Victor Equipment Co.
Wall Colmonoy Corp.—"HARD FACING"
West Virginia Armature Co.
Westinghouse Electric Corp.

WELDING ELECTRODES, NICKEL, NICKEL ALLOY

International Nickel Co., Inc.

WELDING ELECTRODES, CARBON

Crucible Steel Co. of America
Harnischfeger Corp.
Helwig Co.
Hobart Bros. Co.
Lincoln Electric Co.
Marathon Coal Bit Co.
National Carbon Co., Div. of Union Carbide & Carbon Corp.
Ohio Carbon Co.
Pure Carbon Co., Inc.
A. O. Smith Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

WELDING ELECTRODES, GRAPHITE

Helwig Co.
Hobart Bros. Co.
Marathon Coal Bit Co.
National Carbon Co., Div. of Union Carbide & Carbon Corp.
Ohio Carbon Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

WELDING-FLUX RECLAIMING SCREENS

Simplicity Engineering Co.

WELDING FLUXES

Eutectic Welding Alloys Corp.—"EUTECTOR," "FLUXER"
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.
Lincoln Electric Co.
Marathon Coal Bit Co.
Victor Equipment Co.
Westinghouse Electric Corp.

WELDING GASES

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Guyan Machy. Co.
Marathon Coal Bit Co.

WELDING GOGGLES

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
American Optical Co. — "NOVIWELD," "DURAWELD"
E. D. Bullard Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Guyan Machy. Co.
Harnischfeger Corp.
Hobart Bros. Co.
Marathon Coal Bit Co.
Mine Safety Appliances Co.
Ore Reclamation Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.
Victor Equipment Co.
Westinghouse Electric Corp.
Willson Products Div., Ray-O-Vac Co.

WELDING GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co.
Marathon Coal Bit Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"
Tweco Products, Inc.—"TWECO"
Victor Equipment Co.
Westinghouse Electric Corp.

WELDING HELEMETS

American Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Guyan Machy. Co.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co. — "COMFORT SHIELD," "LPH," "FMH"
Marathon Coal Bit Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
A. O. Smith Co.
Westinghouse Electric Corp.
Willson Products Div., Ray-O-Vac Co.

WELDING HOLDERS

Flood City Brass & Electric Co.
Harnischfeger Corp.
Hobart Bros. Co.
Marathon Coal Bit Co.
Westinghouse Electric Corp.

WELDING HOSE

Carlyle Rubber Co., Inc.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hamilton Rubber Mfg. Corp.—"STAPLE"
Harnischfeger Corp.
Hewitt-Robins, Inc.—"TWIN-WELD"
Marathon Coal Bit Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co., Industrial Div.
Victor Equipment Co.
Westinghouse Electric Corp.

WELDING RECTIFIERS

General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Harnischfeger Corp.
Hobart Bros. Co.
Marathon Coal Bit Co.
A. O. Smith Co.
Westinghouse Electric Corp.

WELDING ROD, WIRE

American Brake Shoe Co., Amsco Div.

WELDING SHIELDS

American Optical Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.

Harnischfeger Corp.
Hobart Bros. Co.
Marathon Coal Bit Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
Westinghouse Electric Corp.

WELDING TRANSFORMERS

General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Guyan Machy. Co.—"M & J"
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co.—"IDEAL-ARC", "FLEETWELDER"
Marathon Coal Bit Co.
A. O. Smith Co.
Westinghouse Electric Corp.

WELDMENTS

American Brake Shoe Co., Amsco Div.
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
Connellsville Mfg. & Mine Supply Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
L. O. Koven & Bro., Inc.
R. C. Mahon Co.
Meckum Engr. Co.
Phoenix Iron & Steel Co.
Sanford Day Iron Works, Inc.
A. O. Smith Co.
Wellman Engineering Co., McDowell Enterprise

WELDMENTS, CAST

Electric Steel Foundry Co.

WETTING AGENTS

American Minechem Co.

WHEELBARROWS

Wood Shovel & Tool Co.

WHEELS, LOCOMOTIVE, CAST-IRON

American Car & Foundry Div., ACF Industries, Inc.
Ironton Engine Co.—"IRONTON"
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Pittsburgh Gear Co.

WHEELS, LOCOMOTIVE, STEEL

Bethlehem Steel Co.
Ironton Engine Co.—"IRONTON"
Pittsburgh Gear Co.
Sterling Steel Casting Co.

WHEELS, MACHINE-TRUCK

Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
United States Rubber Co.

WHEELS, MINE-CAR, CAST-IRON

American Brake Shoe Co., Southern Wheel Div.
American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
McLanahan & Stone Corp.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

WHEELS, MINE-CAR, STEEL

American Brake Shoe Co., Amsco Div.
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Irwin Foundry & Mine Car Co.
National Malleable & Steel Castings Co.—"NACO"
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

WINCHES

Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
Indiana Foundry Co.
Joy Mfg. Co.
Ledeen Mfg. Co.
Link-Belt Co.
Lug-All Co.—"LUG-ALL"
Robbins & Meyers, Inc.—"R & M"
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Vickers, Inc., Tulsa Winch Div.—"TULSA"

WINCHES, PIPE DRIVING

Sprague & Henwood

WINDOWS, INDUSTRIAL STEEL

Steelcraft Mfg. Co.

WIRE, ELECTRICAL—See Also Cable

WIRE, ELECTRICAL, BARE

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Phelps Dodge Copper Products Co.
Rome Cable Corp.

WIRE, ELECTRICAL, INSULATED

American Steel & Wire Div., United States Steel Corp.
Collyer Insulated Wire Co.
Complete Reading Electric Co.
Cooke-Wilson Electric Supply Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Cornish Wire Co., Inc.
Electrical Wire & Cable Dept., United States Rubber Co.
Ensign Electric & Mfg. Co.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rockbestos Products Corp.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.
Simplex Wire & Cable Co.

WIRE CLOTH

Ludlow Saylor Wire Cloth Co.

WIRE, FEEDER

Aluminum Company of America
American Steel & Wire Div., United States Steel Corp.
Anaconda Wire & Cable Co.
Collyer Insulated Wire Co.
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.

WIRE, SHOTFIRING

American Steel & Wire Div., United States Steel Corp.
Cornish Wire Co., Inc.
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
King Powder Co., Inc.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Rome Cable Corp.

WIRE, TELEPHONE

American Steel & Wire Div., United States Steel Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Electrical Wire & Cable Dept., United States Rubber Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Page Steel & Wire Div., American Chain & Cable Co., Inc.
National Electric Products Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.

WIRE, THERMOCOUPLE

West Instrument Corp.

WIRE, TROLLEY

American Steel & Wire Div., United States Steel Corp.
Anaconda Wire & Cable Co.
John Flocker & Co.
General Cable Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.

WIRE ROPE

American Chain & Cable—"LAY-SET," "TRU-LAY," "VHS"
American Steel & Wire Div., United States Steel Corp.
Bergen Wire Rope Co.
Bethlehem Steel Co.
Bowdil Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND," "POWERSTEEL"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE"
George E. Failing Co.
John Flocker & Co.
Flood City Brass & Electric Co.
Guyan Machy. Co.
Interstate Equipment Div., Yara Engineering Corp.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Co. Div., H. K. Porter Co. — "HERCULES RED STRAND," "PORTER IMPERIAL RED STRAND"
LeTourneau-Westinghouse Co.—"TOURNA-ROPE"
Macwhyte Co.
Marathon Coal Bit Co.
Mosebach Electric & Supply Co.

National Mine Service Co.
Ore Reclamation Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
W. J. Savage Co.
Union Wire Rope Corp.—"TUFFY"
Upson-Walton Co.
West Virginia Armature Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE CLAMPS

American Hoist & Derrick Co.—"CROSBY"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE"
George E. Failing Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Marathon Coal Bit Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE CLIPS

American Chain & Cable—"ACCO CLIPS"
American Hoist & Derrick Co.—"CROSBY"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Ensign Electric & Mfg. Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
Marathon Coal Bit Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE DRESSING, LUBRICANTS

Ashland Oil & Refining Co.—"ASHLAND"
Cities Service Oil Co.
Esso Standard Oil Co.—"SURETT"
John Flocker & Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
New York & New Jersey Lubricant Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Shell Oil Co.
Sinclair Refining Co.
Sun Oil Co.
Swan-Finch Oil Corp.—"AEROSOL"
The Texas Co.

WIRE-ROPE EYES

American Chain & Cable
John Flocker & Co.
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Union Wire Rope Corp.
Upson-Walton Co.

WIRE-ROPE SHACKLES

American Chain & Cable
American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
Pittsburgh Knife & Forge Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE SOCKETS

American Chain & Cable
American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Bowdil Co.
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
Mosebach Electric & Supply Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Sauerman Bros., Inc.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE SWAGED ASSEMBLIES

American Chain & Cable—"TRU-LOC"
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"BROLOC"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
W. J. Savage Co.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE SWIVELS

American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE-ROPE THIMBLES

American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Laughlin, Thomas, Div., American Hoist & Derrick Co.
Leschen Wire Rope Co. Div., H. K. Porter Co.—"LEPRO"
Macwhyte Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co.
Upson-Walton Co.
Union Wire Rope Corp.
Wire Rope Corp. of America, Inc.

WIRING DEVICES

The Bryant Electric Co.
Cornish Wire Co., Inc.
The Elreco Corp.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
National Electric Products Co.

WOOD PRESERVATIVES

Carbolineum Wood Preserving Co.—"CARBOLINEUM"
Darworth, Inc., Cuprinol Div.—"CUPRINOL"
The Dow Chemical Co.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS," "OSMOPLASTIC," "M-T-M,"
Republic Creosoting Co.
Steelcote Co.—"STEELCOTE," "COPPERITE," "ROT-PROOFING"

WRENCHES, BIT

Duquesne Mine Supply Co.
Guyan Machy. Co.
Joy Mfg. Co.
Leetonia Tool Co.
Marathon Coal Bit Co.
Pittsburgh Knife & Forge Co.
Frank Prox Co., Inc.
Stardrill-Keystone Co.
Bertrand P. Tracy Co.

WRENCHES, HOPPER

Advance Car Mover Co., Inc.—"ADVANCE SAFETY"

WRENCHES, IMPACT

Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Mall Tool Co.—"MALL"
Marathon Coal Bit Co.
Penn Machine Co.
Schroeder Bros.
Snap-on Tools Corp.
Thor Power Tool Co.

WRENCHES, REVERSIBLE RATCHET

Greene, Tweed & Co.—"FAVORITE"

WRENCHES, TORQUE

Bearings, Inc., Owatonna Tool Co.
Ingersoll-Rand Co.
Schroeder Bros.
Snap-on Tools Corp.

WRENCHES, TRACK

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

YO-YOS, HYDRAULIC

The Nolan Co.
Schroeder Bros.
W. R. Stamler Corp.

YO-YOS, ELECTRIC

The Nolan Co.

Coal Age

Directory of Manufacturers

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A G A Division, Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth 3, N. J.
Acker Drill Co., 725 West Lackawanna Ave., Scranton 3, Pa.
Acme Machinery Co., P. O. Box 1169, Williamson, West Va.
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aero Service Co., 236 East Courtland St., Philadelphia, Pa.
Aeroquip Corp., 300 South East Ave., Jackson, Mich., ADV. p 160A
Ahlberg Bearing Co., 3025 West 47 St., Chicago 32, Ill.
Air Reduction Sales Co. Div., Air Reduction Co., Inc., 60 East 42nd Street, New York, N. Y.
Airmite-Midwest, Inc., 119 North Chestnut St., DuQuoin, Ill.
Ajax Flexible Coupling Co., Inc., 100 English St., Westfield, N. Y.
Aldon Co., 3338 Ravenswood Ave., Chicago 13, Ill., ADV. p 200
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa., ADV. p 215
Allen-Bradley Co., 1305 South First St., Milwaukee 4, Wis.
Allen & Garcia Co., 332 South Michigan Ave., Chicago 4, Ill., ADV. p 220
Allen-Sherman-Hoff Pump Co., 259 East Lancaster Ave., Wynnewood, Pa.
Allis-Chalmers Mfg. Co., Buda Div., 1135 S. 70th St., Milwaukee 1, Wis.
Allis-Chalmers Mfg. Co., Construction Machinery Div., Box 512, Milwaukee 1, Wis.
Allis-Chalmers Mfg. Co., Industrial Equipment Div., 1126 South 70 St., Milwaukee 1, Wis., ADV. Insert pp 16-17
The Louis Allis Co., 427 East Stewart St., Milwaukee 7, Wis.
Allison Div., American Chain & Cable Co., Inc., 257 Island Brook Ave., Bridgeport 8, Conn.
Allison Div., General Motors Corp., 4700 W. 10th St., Indianapolis, Ind.
Alloy Rods Co., York, Pa.
Alpha Molykote Corp., 65 Harvard St., Stamford, Conn.
Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.
American Air Filter Co., 215 Central Ave., Louisville 8, Ky., ADV. p 201
American Blower Corp., Detroit 32, Mich.
American Brake Shoe Co., American Brake Blok Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Amsco Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Brake Shoe & Castings Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Denison Eng'g. Co. (Sub.), 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Electro-Alloys Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Kellogg Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., National Bearing Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Ramapo Ajax Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., Southern Wheel Div., 230 Park Ave., New York 17, N. Y.
American Brattice Cloth Corp., Warsaw, Ind., ADV. p 206
American Car & Foundry Div., ACF Industries, Inc., 30 Church St., New York 8, N. Y., ADV. p 183
American Chain & Cable, Wilkes Barre, Pa.
American Chain & Cable Co., Inc., 601 Stephenson Bldg., Detroit 2, Mich.
American Chain & Cable Co., Inc., E. Princess & Charles Sts., York, Pa.
American Chemsol Co., Coraopolis, Pa.
American Conveyor Co., 2133 South Christiana, Chicago, Ill.
American Crucible Products Co., Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Explosives Dept., 30 Rockefeller Plaza, New York 20, N. Y.
American Cyanamid Co., Mineral Dressing Dept., 30 Rockefeller Plaza, New York 20, N. Y., ADV. Insert, pp 160-161
American Engineering Co., Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.
American Flexible Coupling Co., 1960 Pittsburgh Ave., Erie, Pa.
American Hoist & Derrick Co., 63 South Robert St., St. Paul 1, Minn.
American LaFrance Corp., 160 East LaFrance St., Elmira, N. Y.
American-Marsh Pumps, Inc., 59 Capitol Ave., N. E., Battle Creek, Mich.
American Mine Door Co., 2057 Dueber Ave., S. W., Canton 6, Ohio, ADV. p 179
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa., ADV. p 197
American Minechem Co., 641 Fourth Ave., Coraopolis, Pa.
American Oil Co., 555 Fifth Ave., New York 17, N. Y.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo., ADV. p 158
American Steel Foundries, Prudential Plaza, Chicago 1, Ill.
American Steel & Wire Div., United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio, ADV. pp 12-13, 168-169
American Tractor Corp., Churubusco, Ind.
American Well Works, 100 North Broadway, Aurora, Ill.
O. Ames Co., Camden Ave., Parkersburg, West Va.
Jack Ammann Photogrammetric Engineers, Inc., 931 Broadway, San Antonio 5, Texas
Ampco Metal, Inc., 1723 South 38 St., Milwaukee, Wis.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y., ADV. p 160
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Coupling Co., Inc., 340 North Fourth St., Libertyville, Ill.
Anchor Packing Co., 401 North Broad St., Philadelphia 8, Pa.
Albert & J. M. Anderson Mfg. Co., 289 A St., Boston 10, Mass.
Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Ansul Chemical Co., Marinette, Wis.
Anthony Co., Streator, Ill.
Armco Drainage & Metal Prod., Inc., Middletown, Ohio
Armstrong, Bray & Co., 5364 Northwest Hwy., Chicago, Ill.
Arrow Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.

Arrowhead Steel Buildings, Inc., 367 Garfield Avenue, Duluth 6, Minn.
Ashland Oil & Refining Co., Ashland, Ky.
Athey Products Corp., 5631 West 65 St., Chicago 38, Ill.
Atlas Car & Mfg. Co., 1140 Ivanhoe Rd., Cleveland 10, Ohio
Atlas Powder Co., Concord Pike & Murphy Rd., Wilmington, Del.
Auburn Foundry, Inc., Heating Div., Auburn, Indiana
Aurora Pump Div., The New York Air Brake Co., 100 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio
B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I., ADV. p 206
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp., 601 N. Farnsworth Ave., Aurora, Ill.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div., South Main St., Lima, Ohio, ADV. p 180
Axeman-Anderson Co., 223 West St., Williamsport 3, Pa.

B

Babcock & Wilcox Co., 161 East 42 St., New York 17, N. Y.
Baker-Raulang Co., 1250 West 80 St., Cleveland 2, Ohio
Bantam Bearings Div., Torrington Co., 3702 West Sample St., South Bend 21, Ind.
Barber-Greene Co., 400 North Highland Ave., Aurora, Ill.
Barnes Mfg. Co., 615 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Bartlett, C. O., & Snow Co., 6200 Harvard Ave., Cleveland 5, Ohio
Baton & Co., Geo. S., 1100 Union Trust Bldg., Pittsburgh 19, Pa.
Baughman Mfg. Co., Inc., Shipman Rd., Jerseyville, Ill.
Bausch & Lomb Optical Co., 804 St. Paul St., Rochester 2, N. Y.
Bay City Shovels, Inc., Bay City, Mich.
Bayonne Bolt Corp., Bayonne, N. J.
Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Bearings, Inc., 3634 Euclid Ave., Cleveland, Ohio
Beaver Pipe Tools, Inc., 310 Dana Ave., N. E., Warren, Ohio
Bemis Bro. Bag Co., 408-10 Pine St., St. Louis 2, Mo.
Bergen Wire Rope Co., 151 Gregg St., Lodi, N. J.
C. L. Berger & Sons, Inc., Park Square Bldg., 31 St. James St., Boston 16, Mass.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Co., 701 East Third St., Bethlehem, Pa.
Bigelow-Liptak Corp., 2550 West Grand Blvd., Detroit 8, Mich.
Bin-Dicator Co., 13946 Kercheval St., Detroit 15, Mich., ADV. p 216
Bird Machine Co., South Walpole, Mass.
Bituminous Casualty Corp., Iowa-Illinois Bldg., Rock Island, Ill.
Bixby-Zimmer Engineering Co., 961 Abingdon St., Galesburg, Ill., ADV. p 195
Black & Decker Mfg. Co., 600 East Pennsylvania Ave., Towson, Md.
Black Diamond Spad Co., 2108 Stratford Rd., Richmond 25, Va.
Black, Sivalls & Bryson, Inc., 7500 East 12 St., Kansas City 26, Mo.
Blackhawk Mfg. Co., 5325 Rogers Ave., Milwaukee, Wis.
Blaw-Knox Co., Blaw-Knox Bldg., 300 Sixth Ave., Pittsburgh 22, Pa.
Bonded Scale & Machine Co., 17 Bellview, Columbus 7, Ohio
Boston Woven Hose & Rubber Co., P. O. Box 1071, Boston 3, Mass.
Bowdil Co., Boylan Ave., S. E., Canton, Ohio, ADV. p 283
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc., 3040 Hart Ave., Detroit 14, Mich.
Bowser, Inc., 1302 E. Creighton Ave., Fort Wayne, Ind.
Branford Co., 131 Chestnut Co., New Haven 7, Conn.
The Bristol Co., Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
Brooks Oil Co., 934 Ridge Ave., Pittsburgh 12, Pa.
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Dust Collector Co., P. O. Box 133, Hampden, W. Va.
Browning Mfg. Co., Maysville, Ky.
Charles Bruning Co., Inc., 4702 Montrose Ave., Chicago 41, Ill.
Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Brunner & Lay Rock Bit of Philadelphia Inc., 2514 East Cumberland St., Philadelphia 25, Pa.
Brunson Instrument Co., 1405 Walnut St., Kansas City, Mo.
The Bryant Electric Co., Box D, Barnum Station, Bridgeport 2, Conn.
Bucyrus-Erie Co., South Milwaukee, Wis.
Buffalo Forge Co., 490 Broadway, Buffalo 5, N. Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N. Y.
Bulkley, Dunton Processes, Inc., 295 Madison Ave., New York 17, N. Y.
E. D. Bullard Co., 275 Eighth St., San Francisco, Calif.
Burndy Engrg. Co., Inc., Post Rd., Norwalk, Conn.
Bussmann Mfg. Co., 2536 West University St., St. Louis 7, Mo.
Butler Mfg. Co., 7400 East 13th St., Kansas City 26, Mo.
A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Div., Borg-Warner Corp., P. O. Box 2017A, Terminal Annex, Los Angeles 54, Calif.

C

C & D Batteries, Inc., Conshohocken, Pa.
Samuel Cabot, Inc., 141 Milk St., Boston 9, Mass.
Cambridge Wire Cloth, Cambridge, Md.
E. K. Campbell Co., 1809 Manchester Ave., Kansas City 26, Mo.
Canton Stoker Corp., 741 Andrew Place, S. W. Canton, Ohio
Carbolineum Wood Preserving Co., 526 W. Highland Ave., Milwaukee, Wis.
Carboloy Dept., General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich.
C. S. Card Iron Works, P. O. Box 117, Denver 1, Colo.
Cardox Corp., 307 North Michigan Ave., Chicago 1, Ill., ADV. pp 6-7
Philip Carey Mfg. Co., Lockland, Cincinnati 15, Ohio
Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio
Carlyle Rubber Co., Inc., 103-107 Warren St., New York 7, N. Y.
Carolina Tire Co., 232 N. Main St., Salisbury, N. C.
Carpenter Heating & Stoker Co., 2135 St. Clair Ave., Cleveland, Ohio
Carver Pump Co., Muscatine, Iowa
A. W. Cash Co., P. O. Box 551, Decatur, Ill.
A. W. Cash Valve Mfg. Corp., 666 E. Wabash, Decatur, Ill.
Castanoli, Alder F., 1302 W. Va. Bldg., Huntington, W. Va.
Caterpillar Tractor Co., Peoria 8, Ill.
Cement Gun Co., Inc., 1520 Walnut St., Allentown, Pa.
Central Mine Equipment Co., 6200 North Broadway, St. Louis 15, Mo.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centric Clutch Co., P. O. Box 175, Woodbridge, N. J., ADV. p 192
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo., ADV. p 187
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Chain Belt Co., 4786 West Greenfield Ave., Milwaukee 1, Wis.
Chain Belt Co., Shafer Bearing Div., P. O. Box 57, Downers Grove, Ill.
Cheatham Elec. Switching Device Co., 4780 Crittenden Dr., Louisville 9, Ky., ADV. p 218
Chelsea Products, Inc., 639 South Ave., Plainfield, N. J.
Chemical Materials Dept., General Electric Co., Pittsfield, Mass.
Chevrolet Motor Div., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2304 Warren Blvd., Chicago, Ill.
Chicago Perforating Co., 2445 West 24 Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 6 East 44 St., New York, N. Y.
Chiksan Co., 330 North Pomona Ave., Brea, Calif.
J. D. Christian Engineers, 480 Potrero Ave., San Francisco 10, Calif.
Cincinnati Electrical Tool Co., 2694 Madison Rd., Cincinnati 8, Ohio
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio, ADV. p 194
Cincinnati Rubber Mfg. Co., Franklin Ave., Cincinnati 12, Ohio
Cities Service Oil Co., 60 Wall Tower, New York 5, N. Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio
Clark Equipment Co., Construction Machinery Div., P. O. Box 599, Benton Harbor, Mich.
Clark Equip. Co., Automotive Div., Buchanan, Mich.
Clarkson Mfg. Co., Nashville, Ill., ADV. p 189
Cleco Div., Reed Roller Bit Co., P. O. Box 2119, Houston 1, Texas
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio
Cleveland Worm & Gear Co., 3249 East 80 St., Cleveland 4, Ohio
Clyde Iron Works, Inc., Duluth, Minn.
Coast Metals, Inc., Redneck Ave., Little Ferry, N. J.
Cobra Metal Hose, Div., DK Mfg. Co., 4640 W. 54th St., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., 800 Walter St., Danville, Ill.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I., ADV. p 210
Colorado Fuel & Iron Corp., Continental Oil Bldg, Denver Colo. Wickwire Spencer Steel Div., 575 Madison Ave., New York 22, N. Y.
Colorado Iron Works, 1624 17th St., Denver 2, Colo.
Columbia-Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N. Y.
Combustion Engineering, Inc., Raymond Div., 1319 N. Branch St., Chicago, Ill., ADV. p 210
The Commercial Shearing & Stamping Co., 1775 Logan Ave., Youngstown, Ohio
Commercial Testing & Engineering Co., 228 North LaSalle St., Chicago, Ill.

Complete Reading Electric Co, 100 South Jefferson St., Chicago, Ill.
Compton, Inc., P. O. Box 1946, Clarksburg, W. Va., ADV. p 204
Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
R. Conrader Co., 236 West 17th St., Erie, Pa.
Construction Machy. Co., Box 120, Waterloo, Iowa
Continental Gin Co., Industrial Div., P. O. Box 2614, Birmingham 2, Ala.
Continental Rubber Works, 1933 Liberty St., Erie 6, Pa.
Convair, P. O. Box 9671, Pittsburgh 26, Pa.
Cooke-Wilson Electric Supply Co., 3000 Oakhurst Rd., Pittsburgh 34, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engineering Corp., 344 Park Ave., Worcester 2, Mass.
Corhart Refractories Co., 1600 West Lee St., Louisville, Ky.
Cornell-Dubilier Electric Co., South Plainfield, N. J.
Cornish Wire Co., Inc., 50 Church St., New York 7, N. Y.
Cowin & Co., Inc., 1 18th St., SW, Birmingham, Ala.
Cox & Stevens Electronic Scales Div., Revere Corp. of America, Wallingford, Conn.
Crane Co., 836 South Michigan Ave., Chicago 5, Ill.
Crescent Belt Fastener Co., 480 Lexington Ave., New York, N. Y.
Crouse-Hinds Co., Wolf & Seventh North Sts., Syracuse 1, N. Y.
Crucible Steel Co. of America, Henry W. Oliver Bldg., Mellon Sq., Pittsburgh 22, Pa.
Crusher Engineering Div., Poor & Co., 400 Architects' Bldg., 117 S. 17th St., Philadelphia 3, Pa.
Robert A. Cummings, Jr., & Associates, 300 6th Ave., Pittsburgh 22, Pa.
Cummins Engine Co., 1138 Fifth St., Columbus, Ind.
Cutler-Hammer, Inc., 220 N. 12th St., Milwaukee 1, Wis.
Cutter Bit Service Co., 111 West 8th Ave., P.O. Box 533, Huntington, W. Va.

D

D-A Lubricant Co., Inc., 1331 West 29 St., Indianapolis 23, Ind.
Dallas Engineers, Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
Daly Ticket Co., Collinsville, Ill.
The Dana Fan & Blower Corp., 2644 Colerain Ave., Cincinnati 14, Ohio
C. R. Daniels Co., Daniels, Md.
The Daniels Co. Contractors, Inc., 26 North Fifth St., Indiana, Pa., ADV. p 181
Dart Truck Co., 2623 Oak St., Kansas City 8, Mo.
Darworth, Inc., Cuprinol Div., Simsbury, Conn.
Davenport Besler Corp., 2305 Rockingham Rd., Davenport, Iowa
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio, ADV. p 202
Nelson L. Davis Co., 343 S. Dearborn St., Chicago 4, Ill.
Day-Ray Products, Inc., 1133 Mission St., South Pasadena, Calif.
Dayton Automatic Stoker Co., 30 Deeds Ave., Dayton, Ohio
Dayton Rubber Co., 2342 West Riverview Ave., Dayton 1, Ohio
Dean Brothers Pumps, Inc., 323 West Tenth St., Indianapolis 7, Ind.
Deister Concentrator Co., 901 Glasgow Ave., Ft. Wayne 1, Ind.
Deister Machine Co., 1933 East Wayne St., Ft. Wayne 4, Ind.
DeLaval Steam Turbine Co., 855 Nottingham Way, Trenton 2, N. J.
Delta-Star Electric Div., H. K. Porter Co., Inc., 2437 Fulton St., Chicago 12, Ill.
The Deming Co., Salem, Ohio
Denver Equipment Co., P. O. Box 5268, Denver 17, Colo., ADV. p 219
Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Mfg. Co., W. Eighth St., Wyoming, Pa.
Diamond Power Specialty Co., Lancaster, Ohio
Diesel Energy Corp., 82 Beaver St., New York, N. Y.
Dietzgen Co., Inc., Eugene, 218 East 23rd St., New York 10, N. Y.
Differential Steel Car Co., 310 East Hardin St., Findlay, Ohio
Dings Magnetic Separator Co., 4720 West Electric Ave., Milwaukee, Wis.
Henry Disston Div., H. K. Porter Co., Inc., Philadelphia 35, Pa.
Joseph Dixon Crucible Co., Monmouth & Wayne Sts., Jersey City 3, N. J.
Dodge Div., Chrysler Corp., 7900 Jos. Campau, Detroit 31, Mich.
Dodge Mfg. Corp., South Union St., Mishawaka, Ind.
Dooley Brothers, 1201 S. Washington St., Peoria, Ill.
Dorr-Oliver, Inc., Barry Place, Stamford, Conn.
The Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Dowty Mining Equipment, 25 Beaver St., New York 4, N. Y.
Dravo Corp., Neville Island, Pittsburgh 25, Pa., ADV. p 207
Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa.
Drillmaster Supply Co., 1117 Division St., Evansville, Ind.
Drott Mfg. Corp., 3126 S. 27th St., Milwaukee 15, Wis.
Ducon Co., 154 East Second St., Mineola, N. Y.
Duff-Norton Co., 2709 Preble Ave., Pittsburgh, 30, Pa., ADV. p 167

E

E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.
E. I. du Pont de Nemours & Co., Inc., Explosives Div., 2494 Nemours Bldg., Wilmington 98, Del.
E. I. du Pont de Nemours & Co., Inc., Fabrics Div., Wilmington 98, Del.
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 North Main St., Elkhart, Ind.
The Duriron Co., Inc., 450 North Findlay St., Dayton 1, Ohio
Dynamatic Div., Eaton Mfg. Co., 3307-14th Ave., Kenosha, Wis.
Easton Car & Construction Co., Easton, Pa.
Eagle Iron Works, 161 Holcomb Ave., Des Moines 4, Iowa
Eaton Mfg. Co., Axle Div., 739 East 140th St., Cleveland, Ohio
Economy Fuse & Mfg. Co., 2717 N. Greenview Ave., Chicago 14, Ill.
Thomas A. Edison, Inc., Edison Storage Battery Div., Lakeside Ave., West Orange, N. J.
Eimco Corp., 634 South Fourth West St., Salt Lake City, 10, Utah, ADV. p 284
Elastic Stop Nut Corp., 2330 Vauxhall Rd., Union, N. J.
Electric Controller & Mfg. Co., Div. Square D Co., 4500 Lee Rd., Cleveland 28, Ohio
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, Ohio
Electric Steel Foundry Co., 2141 North West 25 Ave., Portland 10, Oregon
Electrical Distributors Co., Penn Square Building, Philadelphia 7, Pa.
Electrical Wire & Cable Dept., United States Rubber Co., 1230 Avenue of the Americas, New York 20, N. Y., ADV. Second Cover
Electro Dynamics Div., General Dynamics, 163 Avenue A, Bayonne, N. J.
Elliott Co., 900 North Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N. Y.
The Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio
Ensign-Bickford Co., Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va.
Enterprise Wheel & Car Corp., Bristol, Tenn.-Va., ADV. p 172
Erico Products, Inc., 2070 East 61 Pl., Cleveland 3, Ohio
Eriez Manufacturing Co., 228 Magnet Drive, Erie, Pa.
Esso Standard Oil Co., 15 West 51 St., New York, N. Y.
Euclid Division, General Motors Corp., 1361 Chardon Road, Cleveland, Ohio
Eureka Casualty Co., (Fire Association Group), 401 Walnut St., Phila. 6, Pa.
Eutectic Welding Alloys Corp., 40-40 172 St., Flushing 58, N. Y.
Evanson, Auchmuty & Summers, 2720 Koppers Bldg., Pittsburgh 19, Pa.
Exide Industrial Div., Electric Storage Battery Co., 42 South 15th St., Philadelphia 2, Pa., ADV. p 16

F

Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
George E. Failing Co., Enid, Okla.
Fairbanks Co., 393 Lafayette St., New York 3, N. Y.
Fairbanks Morse Co., 600 S. Michigan Ave., Chicago 5, Ill.
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15, Calif.
Fairfield Engineering Co., 324 Barnhart St., Marion, Ohio
Fairmont Machinery Co., Fairmont, W. Va.
Falk Corp., 3057 W. Canal St., Milwaukee 1, Wis., ADV. p 178
Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Farris Flexible Valve Corp., 400 Commercial Avenue, Palisades Park, N. J.
Farval Corp., 3249 East 80th St., Cleveland 4, Ohio
Fate-Root-Heath Co., Plymouth, Ohio
Federal Bearings Co., Inc., Poughkeepsie, N. Y.
Federal Motor Truck Co. Div., Napco Industries, Inc., 5780 Federal Ave., Detroit 9, Mich.
Federal Telephone & Radio Co. Div., International Telephone & Telegraph Corp., 100 Kingsland Rd., Clifton, N. J.
Femco, Inc., Irwin, Pa.
Fetterman Engineering Co., 1004 Jtwn. Bank & Trust Bldg., Johnstown, Pa.
Filter Fabrics, Inc., 1279 W. Third St., Cleveland 13, Ohio
Firestone Tire & Rubber Co., Mitchell & Blizzard Aves., Akron 17, Ohio
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.
Fischer & Porter Co., 505 Warminster Rd., Hatboro, Pa.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Fiske Bros. Refining Co., Lubriplate Div., 125 Lockwood St., Newark 5, N. J.
J. H. Fletcher & Co., P. O. Box 353, Huntington, W. Va.
Flexaust Co., 100 Park Ave., New York 17, N. Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.

Flexible Tubing Co., Guilford, Conn., Los Angeles, Calif.
John Flocker & Co., 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Electric Co., Messenger & Elder Sts., Johnstown, Pa.
D. B. Flower Mfg. Co., 1217 Spring Garden St., Philadelphia 23, Pa.
Fly Ash Arrestor Corp., 280 First St. N., Birmingham, Ala.
Food Machinery & Chemical Corp., Peerless Pump Div., 301 West Ave. 26, Los Angeles 31, Calif.
Foote Brothers Gear & Machinery Corp., 4545 South Western Blvd., Chicago, Ill.
Ford Motor Co., P. O. Box 658, Dearborn, Mich.
L. B. Foster Co., P. O. Box 1647, Pittsburgh 30, Pa.
Foster Wheeler Corp., 165 Broadway, New York, N. Y.
Four Wheel Drive Auto Co., Clintonville, Wisconsin
Foxboro Co., Foxboro, Mass.
Franklin Plastics Inc., 315 Grant St., Franklin, Pa.
Frick-Gallagher Mfg. Co., 110 S. Michigan Ave., Wellston, Ohio
Fruehauf Trailer Co., 10940 Harper Ave., Detroit 32, Mich.
Fuel Process Co., D at Tenth St., South Charleston, W. Va.
Fuller Mfg. Co., 1419 North Burdick St., Kalamazoo, Mich.
Fulton Bag & Cotton Mills, General Office, Bag Division, 1400 Annunciation St., New Orleans 13, La.
Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio

G

G & W Electric Specialty Co., 7780 Dante Ave., Chicago 19, Ill.
Galigher Co., 545 West 8th South, P. O. Box 209, Salt Lake City 10, Utah
Galion Allsteel Body Co., 605 S. Market St., Galion, Ohio
Galion Iron Works & Mfg. Co., Galion, Ohio
Gar Wood Industries, Inc., Wayne, Mich.
Gardner-Denver Company, Quincy, Ill.
Garlock Packing Co., 402 East Main St., Palmyra, N. Y.
Gates Rubber Co., 999 South Broadway, Denver 17, Colo., ADV. p 175
General Cable Corp., 420 Lexington Ave., New York 17, N. Y.
General Electric Co., Apparatus Sales Div., 1 River Road, Schenectady 5, N. Y.
General Electric Co., Communication Equipment, Electronics Park, Syracuse, N. Y.
General Electric Co., Construction Materials Dept., 1285 Boston Ave., Bridgeport 2, Conn.
General Electric Co., Distribution Assemblies Dept., 41 Woodford Ave., Plainville, Conn.
General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio
General Electric Co., Semiconductor Products, Electronics Park, Syracuse, N. Y.
General Electric Co., Trumbull Electric Dept., 41 Woodford Ave., Plainville, Conn.
General Mills, Inc., 400 Second Ave., South Minneapolis, Minn.
General Motors Corp., Detroit Diesel Engine Div., 13400 West Outer Dr., Detroit 28, Mich., ADV. p 155
General Motors Corp., New Departure Div., Bristol, Connecticut
General Nuclear Corp., 550 Fifth Ave., New York 14, N. Y.
General Scientific Equipment Co., 27th & Huntington Sts., Philadelphia 32, Pa.
General Splice Corp., 15 Whitehall St., New York, N. Y., & Beckley, W. Va.
General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio
Gensco Tools Div., General Steel Warehouse Co., Inc., 1830 N. Kostner Ave., Chicago 39, Ill.
Geo-Optic Co., Inc., 170 Broadway, New York 38, N. Y.
Gering Products, Inc., North Seventh St., Kenilworth, N. J.
Gibraltar Equipment & Mfg. Co., P. O. Box 304, Alton, Ill.
Gilson Screen Co., 110 Center St., Malinta, Ohio
Goodall Rubber Co., 5 South 36 St., Philadelphia, Pa.
Goodman Mfg. Co., Halsted St. & 48th Place, Chicago 9, Ill.
B. F. Goodrich Industrial Products Co., 500 South Main St., Akron 18, Ohio
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio
Goodyear Tire & Rubber Co., Industrial Prods. Div., 1144 East Market St., Akron 16, Ohio
Gorman-Rupp Co., Mansfield, Ohio
Gould-National Batteries, Inc., 467 Calhoun St., Trenton 7, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Goyne Pump Co., Ashland, Pa.
Gray & Co., Inc., 60 11 Ave., N.E., Minneapolis 13, Minn.
Graybar Elec. Co., Inc., 420 Lexington Ave., New York 17, N. Y., ADV. p 213
Greene, Tweed & Co., North Wales, Pa.
Greensburg Machinery Co., Greensburg, Pa.
Grinnell Co., Inc., 260 West Exchange St., Providence 1, R. I.
Gruendler Crusher & Pulverizer Co., 2917 No. Market St., St. Louis 6, Mo.
Gulf Oil Corp., P. O. Box 1166, Pittsburgh 30, Pa.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc., 226 Centerville Ave., Belleville, Ill., ADV. p 216
Gunite Concrete & Construction Co., 1301 Woodsweather Road, Kansas City 5, Mo.
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va.

H

Hackbridge & Hewittic Electric Co., Ltd., P. O. Box 234, Pittsburgh 30, Pa.
George Haiss Mfg. Co. Div., Pettibone Mulliken Corp., 350 Fifth Ave., New York, N. Y.
Hamilton Rubber Mfg. Corp., Meade St., Trenton, N. J.
J. V. Hammond Co., Spangler, Pa.
F. R. Hannon & Sons, 1605 Waynesburg Rd., Canton 7, Ohio
Hardinge Co., Inc., 240 Arch St., York, Pa.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis., ADV. p 170
Harrington & King Perforating Co., Inc., 5655 West Fillmore St., Chicago 44, Ill.
Hartzell Propeller Fan Co., P. O. Box 909, Piqua, Ohio
Hauck Mfg. Co., 144-154 Tenth St., Brooklyn 15, N. Y.
Herb J. Hawthorne, Inc., Box 7366, Houston 8, Tex.
Hays Corp., 742 E. 8th St., Michigan City, Ind.
Hazemag-MBH, Munster, Germany
The Heil Co., 3000 Montana Ave., Milwaukee 1, Wis.
Heinemann Elec. Co., 98 Plum St., Trenton 2, N. J.
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland, Ohio
Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Helwig Co., 2544 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa., ADV. p 208
Henrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., Mansfield, La.
Hercules Motor Corp., 101 11 St., S.E., Canton, Ohio
Hercules Powder Co., Delaware Trust Bldg., 936 King St., Wilmington, Del.
Hercules Steel Products Co., Galion, Ohio
Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.
Hevi-Duty Electric Co., 4212 W. Highland Blvd., Milwaukee 1, Wis.
Hewitt-Robins, Inc., 666 Glenbrook Rd., Stamford, Conn., ADV. pp 14-15
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.
Hobart Bros. Co., Main & Adams Sts., Troy 1, Ohio
Hockensmith Corp., Penn, Pa.
Hoffman Brothers Drilling Co., Punxsutawney, Pa.
Hoffman Combustion Engrg. Co., 243 West Congress St., Detroit 26, Mich.
Robert Holmes & Bros., Inc., 510 Junction Ave., Danville, Ill.
Holub Industries, Inc., 416 DeKalb Ave., Sycamore, Ill.
Homelite, Div. Textron American, Inc., 75 Riverdale Ave., Port Chester, N. Y.
Homer Mfg. Co., Inc., Dept. 59, Lima, Ohio
Homestead Valve Mfg. Co., Coraopolis, Pa.
Hose Accessories Co., 17 St. & Lehigh Ave., Philadelphia 32, Pa.
Hossfeld Mfg. Co., 460-462 W. Third St., Winona, Minn., ADV. p 214
The Frank G. Hough Co., 735 Seventh St., Libertyville, Ill.
Howe Scale Co., Inc., Rutland, Vt.
Howells Mining Drill Co., Plymouth, Pa.
Hoyt Wire Cloth Co., P. O. Box 22, Lancaster, Pa.
Huber-Warco Co., Marion, Ohio
Hughes Tool Co., 300 Hughes St., Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Aves., Philadelphia 34, Pa.
C. B. Hunt & Son, Inc., Salem, Ohio
Hyatt Bearings Div., General Motors Corp., Harrison, N. J.
Hydramotive, Inc., 6723 Denison Ave., Cleveland 2, Ohio
Hyster Co., 2902 Northeast Clackamas St., Portland 8, Ore.
Hy-Test Safety Shoe Div., International Shoe Co., 1509 Washington Ave., St. Louis 3, Mo.

I

I-T-E Circuit Breaker Co., 19 & Hamilton Sts., Philadelphia 30, Pa.
Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Powder Mfg. Co., 506 Olive St., St. Louis 1, Mo.
Illinois Zinc Co., 2959 W. 47th St., Chicago 32, Ill.
Imperial-Cantrell Mfg. Co., P. O. Box 538 Jellico, Tenn.
Indiana Foundry Co., Indiana, Pa.
Industrial Brownhoist Corp., Bay City, Mich.
Industrial Engrg. & Construction Co., Inc., First National Bank Bldg., Fairmont, W. Va.
Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.
Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., ADV. p 1
Inland Steel Co., 38 South Dearborn St., Chicago 3, Ill.
Insley Mfg. Corp., 801 Olney St., Indianapolis 6, Ind.
Instrument Div., Gichner, Inc., 1900 Kendall St., N.E., Washington 2, D. C.

Insul-Mastic Corp. of America, 7750 West 61 Place, Summit, Ill.
International Harvester Co., Construction Equipment Div., 180 N. Michigan Ave., Chicago 1, Ill.
International Harvester Co., Motor Truck Div., 180 North Michigan Ave., Chicago 1, Ill.
International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.
International Salt Co., Inc., Scranton 2, Pa.
Interstate Equipment Div., Yara Engineering Corp., 18 West Jersey St., Elizabeth 4, N. J.
Iowa Mfg. Co., 916 16 St., N.E., Cedar Rapids, Iowa
Ironton Engine Co., Farmingdale, N. J.
Irwin Foundry & Mine Car Co., Irwin, Pa.

J

Jaeger Machine Co., 550 W. Spring St., Columbus, Ohio
James Gear Mfg. Co., D.O., 1114 West Monroe St., Chicago 7, Ill.
Jeffrey Mfg. Co., 922 North Fourth St., Columbus 16, Ohio
Jenkins Bros., 100 Park Ave., New York 17, N. Y.
Jesco Lubricants Co., P. O. Box 7331, Kansas City 16, Mo.
Jet-Lube, Inc., 3093 North California St., Burbank, California
Johns-Manville, 22 East 40 St., New York 16, N. Y.
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa.
Johnson Plastics Corp., P. O. Box 268, Chagrin Falls, Ohio
R. G. Johnson Co., Washington Trust Bldg., Washington, Pa.
Johnston Pump Co., P. O. Bin K, Pasadena, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa., ADV. pp 145, 146
Joy Mfg. Co., Oliver Bldg., 3 Fl., Pittsburgh 22, Pa., ADV. pp 161, 162-65, 166
Joyce Cridland Co., 2027 East First St., Dayton 3, Ohio
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.

K

K. W. Battery Co., Inc., 3555 Howard St., Skokie, Ill.
Kanawha Mfg. Co., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., Parkway Dr., Cincinnati, Ohio
Kennametal, Inc., Latrobe, Pa., ADV. pp 176-177
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kennedy-Van Saun Mfg. & Engrg. Corp., 2 Park Ave., New York, N. Y.
Kensington Steel Co., 505 East Kensington Ave., Chicago 28, Ill.
The Kerite Co., 30 Church St., New York 7, N. Y.
Kern Instruments, Inc., 120 Grand St., White Plains, N. Y.
Kersey Mfg. Co., Inc., P. O. Box 151, Bluefield, Va., ADV. p 176
Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.
Keystone Carbon Co., 1933 State St., St. Marys, Pa.
Keystone Lubricating Co., 21 & Clearfield Sts., Philadelphia 32, Pa.
Walter Kidde & Co., Inc., 357 Main St., Belleville 9, N. J.
King Powder Co., Inc., 1703 First National Bank Bldg., Cincinnati 1, Ohio
S. P. Kinney Engineers, Inc., 201 Second Ave., Carnegie, Pa.
Kirk & Cowin, 1 18th St. SW, Birmingham, Ala.
Koehring Co., 31 & Concordia Ave., Milwaukee 16, Wis.
Koppers Co., Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md.
Koppers Co., Inc., Wood Preserving Div., Koppers Bldg., Pittsburgh 19, Pa., ADV. p 209
L. O. Koven & Bro., Inc., 154 Ogden Ave., Jersey City 7, N. J.
Kremser & Sons, Inc., Frank A., 3435 North Fifth St., Philadelphia, Pa.
Kuhlman Elec. Co., 26 & Jefferson Sts., Bay City, Mich.

L

Laboratory Equipment Corp., St. Joseph, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Laclede Stoker Co., 4438 Hunt Ave., St. Louis 10, Mo.
Ladish Co., 5481 S. Packard Ave., Cudahy, Wis.
Lancaster Pump & Mfg. Co., Lancaster, Pa.
Laubenstein Mfg. Co., Ashland, Pa.
Laughlin, Thomas, Div., American Hoist & Derrick Co., 143 Fore St., Portland 6, Me.
Layne & Bowler, Inc., Box 6697, Hollywood Sta., Memphis 8, Tenn.
Lecco Engrg. & Mfg. Co., Box 3036, Bluefield, W. Va.
Ledeen Mfg. Co., 1600 South San Pedro St., Los Angeles, Calif.
Lee-Norse Co., Charleroi, Pa.
Leetonia Tool Co., 142 Main St., Leetonia, Ohio
Lehigh Safety Shoe Co., Inc., First & Minor Sts., Emmaus, Pa.
Leland Electric Co., Div. American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio
Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, Wis., ADV. p 157
Leschen Wire Rope Co. Div., H. K. Porter Co., 2727 Hamilton Ave., St. Louis 12, Mo.
LeTourneau-Westinghouse Co., 2301 North Adams St., Peoria, Ill., ADV. pp 184-85
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp., 600 Grant St., Pittsburgh 19, Pa.
Linatex Corp. of America, Rockville, Conn.
Lincoln Electric Co., 22801 St. Clair, Cleveland 17, Ohio
Lincoln Engrg. Co., 5701 Natural Bridge Ave., St. Louis 20, Mo., ADV. p 191
Link-Belt Co., Prudential Plaza, Chicago 1, Ill.
Link-Belt Speeder Corp., Cedar Rapids, Iowa
Lippmann Engrg. Works, 4603 West Mitchell St., Milwaukee, Wis.
Herbert S. Littlewood, R. D. 3, Irwin, Pa.
Peter F. Loftus Corp., First National Bank Bldg., Pittsburgh 22, Pa.
The Long Co., P. O. Box 331, Oak Hill, W. Va.
E. J. Longyear Co., 1701 Foshay Tower, Minneapolis, Minn.
Lovejoy Flexible Coupling Co., 4890 West Lake St., Chicago, Ill.
Ludlow Saylor Wire Cloth Co., 634 South Newstead, St. Louis, 10, Mo., ADV. p 200
Ludlow Valve Mfg. Co., Inc., P. O. Box 388, Troy 1, N. Y.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lug-All Co., 355 Lancaster Ave., Haverford, Pa.
Lunkenheimer Co., Beekman St. and Waverly Ave., Cincinnati 14, Ohio

M

Mack Trucks, Inc., 1355 West Front St., Plainfield, N. J.
Macwhyte Co., 2931 14th Ave., Kenosha, Wis.
Magic Chemical Co., 101 Crescent St., Brockton 2, Mass.
Magnetic Engrg. & Mfg. Co., 851 Van Houten Ave., Clifton, N. J.
R. C. Mahon Co., 6565 East Eight Mile Rd., Detroit 34, Mich.
Majac, Inc., 23 St. & P.R.R., Sharpsburg, Pittsburgh 15, Pa.
Mall Tool Co., 7740 S. Chicago Ave., Chicago 19, Ill.
Manheim Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.
Manitowoc Engineering Corp., South 16th St., Manitowoc, Wis., ADV. p 296
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div., Muskegon, Mich.
Manu-Mine Research & Development Co., P. O. Box 167, Reading, Pa.
Manzel Div., Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N. Y.
Marathon Coal Bit Co., P. O. Box 529, Montgomery, W. Va.
Marietta Concrete Corp., Box 356, Marietta, Ohio
Marietta Mfg. Co., Point Pleasant, W. Va.
Marion Handle Mills, Inc., Marion, Va.
Marion Metal Products Co., Chaney Ave., Marion, Ohio
Marion Power Shovel Co., Marion, Ohio
Marland One-Way Clutch Co., 561 Hillgrove Ave., La Grange, Ill.
Marlin-Rockwell Corp., 402 Chandler St., Jamestown 55, N. Y.
Marlow Pumps, Div. of Bell & Gossett Co., Box 200, Midland Park, N. J.
Marmon-Herrington Co., Inc., 1511 West Washington St., Indianapolis 7, Ind.
E. F. Marsh Engrg. Co., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engrg. Co., Neponset, Ill.
Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio
Marvel Engr. Co., 7227 N. Hamlin Ave., Chicago 45, Ill.
Maryland Bolt & Nut Co., Mt. Washington, Baltimore 9, Md.
Master Bronze Powder Co., 5009 Calumet Ave., Hammond, Ind.
Master Electric Co., 126 Davis Ave., Dayton 1, Ohio
Mayhew Supply Co., Inc., P. O. Box 7726, 4700 Scyene Rd., Dallas, Texas
Mayo Tunnel & Mine Equipment Co., Lancaster, Pa.
McGill Mfg. Co., Inc., Valparaiso, Ind.
McLanahan & Stone Corp., Hollidaysburg, Pa., ADV. p 147
McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.
McNally-Pittsburg Mfg. Corp., 307 West 3d St., Pittsburg, Kan., ADV. Insert 144-45
Mechanical Industries, Inc., 541 Wood St., Pittsburgh 22, Pa.
Meckum Engr. Co., 53 West Jackson Blvd., Chicago 4, Ill.
John F. Meissner Engineers, Inc., 308 W. Washington St., Chicago 6, Ill.
Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N. J., ADV. p 212
Metal Carbides Corp., 6001 Southern Blvd., Youngstown 12, Ohio
Metal & Thermit Corp., 100 East 42 St., New York 17, N. Y.
Metallizing Engrg. Co., Inc., 1101 Prospect Ave., Westbury, N. Y.
Mexico Refractories Co., Mexico, Mo.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Michigan Pipe Co., 6581 Mills St., Gagetown, Mich.
Midland Pipe & Supply Co., 2829 S. 61st St., Chicago, Ill.
Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa., ADV. pp 8-9
Miners' Hardware Supply Co., 525½ Brushton Ave., Pittsburgh 21, Pa., ADV. p 218

Mining Machine Parts Inc., 2701 St. Clair Ave., Cleveland, Ohio
Mining Progress, Inc., P. O. Box 3, Highland Mills, N. Y.
Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Phila. 44, Pa.
Minneapolis-Moline Co., Box 1050, Minneapolis 1, Minn.
Minnesota Mining & Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.
Minnesota Mining & Mfg. Co., Irvington Div., 6 Argyle Terrace, Irvington 11, N. J.
Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.
Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.
Mobile Drilling Co., Inc., 960 North Pennsylvania St., Indianapolis 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., Organic Chemicals Div., 800 N. 12 Blvd., St. Louis 1, Mo.
The Moore Co., 1036 Quarrier St., Charleston, W. Va.
Morris Machine Works, Baldwinsville, N. Y., ADV. p 2
Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver 1, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.
Mosebach Electric & Supply Co., 1115 Arlington Ave., Pittsburgh 3, Pa.
T. J. Moss Tie Co., 700 Security Bldg., St. Louis 2, Mo.
Motorola Communications & Electronics, Inc., 4501 West Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va.
Mount Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo.
Murphy Diesel Co., 5317 West Burnham St., Milwaukee, Wis.
Myers-Whaley Co., P. O. Box 789, Knoxville 1, Tenn.

N

Nachod & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky., ADV p 218
Nagle Pumps, Inc., 1249 Center Ave., Chicago Heights, Ill.
Nash Engineering Co., South Norwalk, Conn.
Nathan Mfg. Corp., 45-02 Ditmars Blvd., Long Island City 5, N. Y.
National Carbon Co., Div. of Union Carbide & Carbon Corp., 30 East 42nd St., New York 17, N. Y.
National Electric Coil Co., 800 King Ave., Columbus 16, Ohio
National Electric Products Co., Gateway Center, Bldg. 2, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland 6, Ohio, ADV. p 196
National Mine Service Co., 1260 Maple St., Indiana, Pa.
National Powder Co., Eldred, Pa.
National Supply Company, 2 Gateway Center, Pittsburgh, Pa.
National Tube Div., United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.
Naylor Pipe Co., 1262 E. 92 St., Chicago 19, Ill.
Neff & Fry Co., Camden, Ohio
Newcomer Products, Inc., Latrobe, Pa.
New Departure Div., General Motors Corp., Bristol, Conn.
New Era Engineering Co., Dept. G-76, 458 W. 29th St., Chicago 16, Ill.
New Jersey Meter Co., Plainfield, N. J.
New York Air Brake Co., 230 Park Ave., New York 17, N. Y.
New York Belting & Packing Co., 1 Market St., Passaic, N. J.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
Newark Wire Cloth Co., 370 Verona Ave., Newark 4, N. J.
Alford G. Newell, 509 Oliver Bldg., Pittsburgh 22, Pa.
R. W. Nichols Co., 101 Investment Bldg., Pittsburgh 22, Pa.
The Nolan Co., Bowerston, Ohio, ADV. p 156
Nordberg Mfg. Co., 3073 South Chase Ave., Milwaukee 1, Wis., ADV. Fourth Cover
Norma-Hoffman Bearing Corp., Stamford, Conn.
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.

O

Ohio Brass Co., Mansfield, Ohio
Ohio Carbon Co., 12508 Berea Road, Cleveland 11, Ohio
Ohio Oil Co., Findlay, Ohio
Okonite Co., Canal St., Passaic, N. J.
Old Republic Insurance Co., 414 West Pittsburgh St., Greensburg, Pa.
Olin-Mathieson Chemical Corp., Explosives Div., East Alton, Ill.
Oliver Corp., 400 West Madison St., Chicago 6, Ill.
Oliver Iron & Steel Corp., South 10th & Muriel St., Pittsburgh 3, Pa.
Onox, Inc., 121 Second St., San Francisco, 5, Calif.
Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.
The Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Ore Reclamation Co., 313 Wall St., Joplin, Mo.
Orefraction, Inc., 7425 Thomas St., Pittsburgh 8, Pa.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Oshkosh Motor Truck, Inc., Oshkosh, Wis.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

P

Page Engineering Co., Clearing Post Office, Chicago 38, Ill., ADV. p 177
Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.
Palnut Co., Glen Road, Mountainside, N. J.
Pangborn Corp., 670 Pangborn Blvd., Hagerstown, Md.
Paris Mfg. Co., Paris, Ill.
Pattin Mfg. Co., Marietta, Ohio
Peerless Photo Products, Inc., Shoreham, N. Y.
Penn Machine Co., 106 Station St., Johnstown, Pa.
Pennsylvania Crusher Div., Bath Iron Works Corp., Room 1711, West Chester, Pa., ADV. p 182
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.
Pennsylvania Electric Coil Corp., 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., Butler, Pa.
Perfection Steel Body Co., Galion, Ohio
Permutit Co., 330 West 42 St., New York 36, N. Y.
Peterson Filters & Engineering Co., 137 Social Hall Ave., Salt Lake City, Utah
Pettibone Mulliken Co., 4710 West Division St., Chicago 51, Ill.
J. B. Pfister Co., 662 Ohio St., Terre Haute, Ind.
Phelps Dodge Copper Products Co., 300 Park Ave., New York 22, N. Y.
Philadelphia Gear Works, Erie Ave. & G Sts., Philadelphia 34, Pa.
Phillips Petroleum Co., Bartlesville, Okla.
Phoenix Iron & Steel Co., Phoenixville, Pa.
Phoenix Metal Products, Metal Spinning Div., 4715 North 27 St., Milwaukee, Wis.
Pierce Management, Inc., Scranton Electric Bldg., Scranton 3, Pa.
Pioneer Engineering Works, 1515 Central Ave., Minneapolis 13, Minn.
Pitman Manufacturing Co., 300 West 79th Terrace, Kansas City 14, Mo.
Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.
Pittsburgh Knife & Forge Co., 1421 Reedsdale St., Pittsburgh 33, Pa.
Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Screw & Bolt Corp., P. O. Box 1708, Pittsburgh 30, Pa.
Plastex Co., 402 Mt. Vernon Ave., Columbus 3, Ohio
Plymouth Rubber Co., Canton, Mass., ADV. p 197
H. K. Porter, Inc., 74 Foley St., Somerville, Mass.
Porto Pump, Inc., 19735 Ralston, Detroit 3, Mich.
Post Glover Electric Co., 221 West Third St., Cincinnati 2, Ohio
Prime Mover Co., Muscatine, Iowa
K. Prins & Associates, Wellston, Ohio
Productive Equipment Corp., 2926 West Lake St., Chicago 12, Ill.
Frank Prox Co., Inc., 1201 South 1st St., Terre Haute, Ind., ADV. p 159
Pulmosan Safety Equip. Co., 644 Pacific St., Brooklyn, N. Y.
Pure Carbon Co., Inc., 441 Hall Ave., St. Marys, Pa.
Pure Oil Co., 35 East Wacker Dr., Chicago 1, Ill.

Q

Quaker Rubber Div., H. K. Porter Co., Inc., Tacony & Comly Streets, Phila. 24, Pa.
Quick-Way Truck Shovel Co., 2401 E. 40th Ave., Denver, Colo.

R

R-P & C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Radiant Lamp Corp., 300 Jelliff Ave., Newark 8, N. J.
Radio Corp. of America, Commercial Electronic Products, Camden 2, N. J.
Raybestos Manhattan, Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Read, Davis, 120 South La Salle St., Chicago, Ill.
Ready Power Co., 11231 Freud Ave., Detroit, Mich.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co., 1225 7th St., Columbus, Ind.
Reich Bros. Mfg. Co., Inc., 1439 Ash St., Terre Haute, Ind., ADV. p 171
Reid Belt & Rubber Co., 363 Bluefield Ave., Bluefield, W. Va.
George P. Reintjes Co., 2517-19 Jefferson St., Kansas City 6, Mo.
Reliance Elec. & Eng. Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio
Reliance Electric & Engineering Co., Reeves Pulley Co. Div., 1225 Seventh St., Columbus, Ind.
Remaly Mfg. Co., Tamaqua, Pa.

Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Reo Motors, Inc., 1331 South Washington St., Lansing 20, Mich.
Republic Creosoting Co., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
Republic Rubber Div., Lee Rubber & Tire Co., Youngstown 1, Ohio
Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio
Resisto-Loy Co., Inc., 1251 Phillips Ave., S.W., Grand Rapids 7, Mich.
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Reynolds Metals Co., 2500 South Third St., Louisville 1, Ky.
Rice Pump & Machine Co., Belgium, Wis.
Ridge Equipment Co., Fallentimber, Pa.
Riegel Textile Corp., 260 Madison Ave., New York, N. Y.
Riggs Engineering Co., Box 133, Ludlow, Ky.
Robbins & Meyers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc., 130 N. Wells St., Chicago 6, Ill., ADV. p 190
Robinson & Robinson, Union Bldg., Charleston, West Va.
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes, Inc., Culpeper, Va.
Rockbestos Products Corp., 285 Nicoll Ave., New Haven 4, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
John A. Roebling's Sons Co. Div., Colorado Fuel & Iron Co., 640 South Broad St., Trenton 2, N. J.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N. Y.
Rome Cable Corp., 330 Ridge St., Rome, N. Y., ADV. p 154
Roots-Connersville Blower Div., Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind.
Ross Screen & Feeder Co., 100 Quimby St., Westfield, N. J.
Ruberoid Co., 500 Fifth Ave., New York 36, N. Y., ADV. p 203
Ruger Equipment, Inc., 615 W. 4th St., Uhrichsville, Ohio
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Rydin Railway Equip. Co., Railway Exch. Bldg., Chicago 4, Ill.
Joseph T. Ryerson & Son, Inc., 16 & Rockwell Sts., P. O. Box 8000A, Chicago 80, Ill.

S

SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Saginaw Bearing Co., 821 South Water St., Saginaw, Mich.
St. Louis Screw & Bolt Co., 6900 North Broadway, St. Louis 15, Mo.
Salem-Brosius, Inc., P. O. Box 2222, Pittsburgh 30, Pa., ADV. p 211
Salem Tool Co., 766 S. Ellsworth Ave., Salem, Ohio, ADV. p 153
Sanford Day Iron Works, Inc., P. O. Box 1511, Knoxville 9, Tenn.
Sauerman Bros., Inc., 620 South 28th Ave., Bellwood, Ill.
W. J. Savage Co., 912 Clinch Ave., Knoxville 2, Tenn.
Scandinavia Belting Co., P. O. Box 464, Newark 1, N. J.
Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.
Schield Bantam Co., 221 Park St., Waverly, Iowa
Schramm, Inc., West Chester, Pa.
Schroeder Bros., 3116 Penn Ave., Pittsburgh 1, Pa.
Scranton Electric Construction Co., 625 Connell Bldg., Scranton, Pa.
Screen Equipment Co., 1750 Walden Ave., Buffalo, N. Y.
Seiberling Rubber Co., Akron 9, Ohio
Sheffield Steel Div., Armco Steel Corp., Sheffield Sta., Kansas City, Mo.
Shell Oil Co., 50 W. 50th St., New York, N. Y.
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Montour Falls, N. Y.
R. H. Sheppard Co., Inc., Hanover, Pa.
Sight Feed Generator Co., West Alexandria, Ohio
Sika Chemical Corp., 33-47 Gregory Ave., Passaic, N. J.
Silver Engineering Works, Inc., 3309 Blake St., Denver 5, Colo., ADV. p 193
Simonds Saw & Steel Co., Fitchburg, Mass.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Simplicity Engineering Co., Durand, Mich., ADV. Third Cover
Sinclair Refining Co., 600 Fifth Ave., New York 20, N. Y.
Singer Mfg. Co., Diehl Mfg. Div., Trumbull & First Sts., Somerville, N. J.
Slip-On, Inc., 401 Broadway, New York, N. Y.
J. K. Smit & Sons, Murray Hill, N. J.
A. O. Smith Co., 3533 N. 27th St., Milwaukee 1, Wis.
Smith Engineering Works, 502 East Capital Dr., Milwaukee, Wis.
Snap-On Tools Corp., 8132 28 Ave., Kenosha, Wis.
The Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7, Conn.
Socony Mobil Oil Co., 26 Broadway, New York 4, N. Y.
Solvay Sales Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.
South Bend Lathe Works, South Bend 22, Ind.
Spang & Company, P. O. Box 751, Butler, Pa.
Speer Carbon Co., St. Marys, Pa.
Spencer Chemical Co., 1004 Baltimore Ave., Kansas City, Mo.
Sperry Rand Corp., Remington Rand Div., 315 Fourth Ave., New York 10, N. Y.
Sprague & Henwood, 221 West Olive St., Scranton, Pa., ADV. p 188
W. F. Sprengnether Instrument Co., Inc., 4576 Swan Ave., St. Louis 10, Mo., ADV. p 214
Sprout, Waldron & Co., Inc., Muncy, Pa.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Stackpole Carbon Co., St. Marys, Pa.
W. R. Stamler Corp., Paris, Ky., ADV. p 174
Standard Carbon Co., P. O. 49, Steubenville, Ohio
Standard Electric Tool Co., 2488 River Rd., Cincinnati 4, Ohio
Standard Oil Co. (Ind.), 910 South Michigan Ave., Chicago 80, Ill.
Standard Stamping & Perf. Co., 3131 West 49 Pl., Chicago, Ill.
Star Jack Co., Inc., 420 Lexington Ave., New York 17, N. Y.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co., 200 Bloomfield Ave., Bloomfield, N. J.
Stardrill-Keystone Co., 920-17th St., Beaver Falls, Pa.
Stearns Magnetic, Inc., 663 So. 28th St., Milwaukee 46, Wis.
Stearns-Roger Mfg. Co., 660 Bannock St., Denver 4, Colo.
Stedman Foundry & Machine Co., Inc., Aurora, Ind.
Steel-Bilt Construction Co., P. O. Box 309, Bridgeville, Pa.
Steelcote Co., 3418 Gratiot St., St. Louis, Mo.
Steelcraft Mfg. Co., 9066 Blue Ash Rd., Rossmoyne, Ohio
Stephens-Adamson Mfg. Co., 82 Ridgeway Ave., Aurora, Ill.
Sterling Steel Casting Co., P. O. Box 230, East St. Louis, Ill.
Stewart-Warner Corp., Alemite Div., 1826 Diversey Pkwy., Chicago 14, Ill.
Stonhard Co., 1306 Spring Garden St., Philadelphia 23, Pa.
Stoody Co., 11943 East Slauson Ave., Whittier, Calif.
Stop Fire, Inc., 125 Ashland Place, Brooklyn 1, N. Y.
Straub Mfg. Co., Inc., 8383 Baldwin St., Oakland 21, Calif.
Streeter-Amet Co. 4101 Ravenswood Ave., Chicago, Ill.
Stulz-Sickles Co., 134 Lafayette St., Newark 5, N. J.
Sturtevant Mill Co., 103 Clayton St., Dorchester, Boston 22, Mass.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.
Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio.
Peter O. Sutphen, P. O. Box 58, Everett, Pa.
Suverkrop Instruments, P. O. Box 436, Bakersfield, Calif.
Swan, Finch Oil Corp., 338 Hudson St., Hackensack, N.J.
Syntron Co., 975 Lexington Ave., Homer City, Pa.

T

Talcott, Inc., 91 Sabin St., Providence 1, R. I.
Talk-A-Phone 1514 S. Pulaski Rd., Chicago 23, Ill.
Taller & Cooper, 75 Front St., Brooklyn, N. Y.
Tamping Bag Co., Mt. Vernon, Ill.
Taylor Forge & Pipe Works, Box 485, Chicago 90, Ill.
Taylor-Wharton Co. Div., Harsco Corp., High Bridge, N. J.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill., ADV. p 217
Templeton-Matthews Corp., 905 Sycamore Bldg., Terre Haute, Ind.
The Texas Co., 135 East 42nd St., New York 17, N. Y., ADV. pp 4-5
Thermoid Co., Industrial Div., Whitehead Rd., Trenton 6, N.J.
Thew Shovel Co., Lorain, Ohio.
Thomas Engineering & Construction Co., Box 646, Greensburg, Pa.
Thomas Flexible Coupling Co., Main Ave. & Biddle St., Warren, Pa.
Thor Power Tool Co., 175 North State St., Aurora, Ill.
Throwaway Bit Corp., 4200 N. W. Yeon Ave., Portland 10, Ore.
Thurman Machine Co., 156 North Fifth St., Columbus, Ohio
Tide Water Associated Oil Co., 17 Battery Pl., New York 4, N. Y.
Timken Detroit Axle Div., Rockwell Spring & Axle Co., 100-400 Clark St., Detroit 32, Mich.
The Timken Roller Bearing Co., Dueber Ave., Canton 6, Ohio
Toledo Pipe Threading Machine Co., 1445 Summit Ave., Toledo 4. Ohio
Toledo Scale Co., 1106 Telegraph Rd., Toledo 1, Ohio
The Tool Steel Gear & Pinion Co., 211 Township Ave., Cincinnati 16, Ohio, ADV. p 186
H. & L. Tooth Co., 1540 South Greenwood Ave., Montebello, Calif.
Torrington Co., 59 Field St., Torrington, Conn.
Trabon Engineering Co., 1814 East 40th St., Cleveland, Ohio
Tractomotive Corp., Box 632, County Line Rd., Deerfield, Ill.
Bertrand P. Tracy Co., 919 Fulton St., Pittsburgh 12, Pa., ADV. p 148
Transall, Inc., 109 North 11 St., Birmingham 4, Ala.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Tri-County Building Service, P. O. Box 405, Taylorville, Ill.
Triangle Conduit & Cable Co., 1908 Jersey Ave., New Brunswick, N. J.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.
Trombetta Solenoid Corp., 329 N. Milwaukee Street, Milwaukee 2, Wis.
Truck Engineering Co., 1285 W. 70th St., Cleveland 2, Ohio
Tube Turns, Div., National Cylinder Gas Co., 224 E. Broadway, Louisville 1, Ky.
Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.
Tweco Products, Inc., 1450 South Mosley, Wichita 1, Kan.
Twin Disc Clutch Co., Racine, Wisc.
W. S. Tyler Co., 3615 Superior Ave., Cleveland 14, Ohio
Tyson Bearing Corp., sub. of SKF Industries, Inc., Massillon, Ohio

U

Union Switch & Signal Div., Westinghouse Air Brake Co., Pittsburgh 18, Pa.
Union Wire Rope Corp., 2100 Manchester Ave., Kansas City 26, Mo.
Unit Crane & Shovel Corp., 6411 West Burnham St., Milwaukee 14, Wisc.
United Engineers & Constructors Inc., 1401 Arch St., Philadelphia 5, Pa.
U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles 54, Calif.
U. S. Hoffman Machinery Corp., Industrial Div., 103 Fourth Ave., New York 3, N. Y.
United States Pipe & Foundry Co., 3300 First Ave., Birmingham 2, Ala.
United States Rubber Co., 1230 Ave. of the Americas, New York 20, N. Y., ADV. Second Cover
U. S. Safety Service Co., 1331 Oak St., Kansas City 6, Mo.
U. S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.
Universal Engineering Co., 625 C Ave., Northwest, Cedar Rapids, Iowa
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd. & St. Paul R. R., Racine, Wisc.
Upson-Walton Co., 12515 Elmwood Ave., Cleveland 11, Ohio
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 24, Mo.

V

Valvoline Oil Co., Div. Ashland & Refining Co., 639 Third Ave., Freedom, Penna.
R. T. Vanderbilt Co., 230 Park Ave., New York, N. Y.
Varel Mfg. Co., Inc., 9230 Denton Dr., Dallas, Texas
Vascoloy-Ramet Corp., 800 Market St., Waukegan, Ill.
Vickers Inc., Div. Sperry Rand Corp. Detroit 32, Mich.
Vickers, Inc., Tulsa Winch Div., 815 East First St., Tulsa 20, Okla.
Victaulic Co. of America, Box 509, Elizabeth, N. J., ADV. p 173
Victor Equipment Co., 844 Folsom St., San Francisco 7, Calif.
Viking Machinery Sales Corp., 205 O'Brien Rd., Jackson, Mich.
Vincennes Steel Corp., Vincennes, Ind.
Visking Corp., Plastics Div., P. O. Box 1410, Terre Haute, Ind.
Vulcan Iron Works, 730 South Main St., Wilkes Barre, Pa.

W

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.
Waljohn Plastics Co., 435-441 88 St., Brooklyn 1, N. Y.
Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.
Walter Motor Truck Co., 1001-19 Irving Ave., Ridgewood, L. I., N. Y.
Walworth Co., 60 East 42nd St., New York 17, N. Y.
Warner Laboratories, Cresson, Pa., ADV. p 212
Warren Refining & Chemical Co., 5151 Denison Ave., Cleveland 2, Ohio
Warren Steam Pump Co., Warren, Mass.
Water Neutralizing Co., Box 315, Columbia, Mo.
Watt Car & Wheel Co., Barnesville, Ohio
Waukesha Motor Co., West St Paul Ave., Waukesha, Wis.
Weatherhead Co., Fort Wayne Div., 128 W. Washington St., Fort Wayne, Ind.
Webb Corp., Box 549, Webb City, Mo.
Webster Mfg. Co., Tiffin, Ohio
Wedge Wire Corp., Gas St. & N. P. R. R., Wellington, Ohio, ADV. p 205
Wellman Engineering Co., McDowell enterprise., 7000 Central Ave., Clveland 4, Ohio
S. K. Wellman Co., 200 Egbert Rd., Bedford, Ohio
West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
West Virginia Armature Co., Bluefield, W. Va.
W. Va. Belt & Cable Repairs, Inc., P. O. Box 361, Mount Hope, W. Va.
West Virginia Electric Corp., 739 Merchant St., Fairmont, W. Va.
West Virginia Steel & Mfg. Co., 17 & Second Ave., Huntington 6, W. Va.
Western Machinery Co., 760 Folsom St., San Francisco 7, Calif., ADV. pp 10-11
Western Precipitation Corp., 1000 West Ninth St., Los Angeles 15, Calif.
Westinghouse Electric Corp., 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. ADV. pp 149-152
Westinghouse Electric Corp., B. F. Sturtevant Div., Hyde Park, Boston, Mass.
Wheelabrator Corp., 311 South Byrkit St., Mishawaka, Ind.
Wheeler Insulated Wire Co., Inc., Div. Sperry Rand Corp., 150 East Aurora St., Waterbury, Conn.
Wheeling Steel Corp., Wheeling Steel Bldg., Wheeling, W. Va.
Whiting Corp., Harvey, Ill.
Whitmore Mfg. Co., 3816 Iron Court, Cleveland 15, Ohio
Whitney Chain Co., 237 Hamilton St., Hartford 2, Conn.
Wilbur & Williams Co., 130 Lincoln St., Brighton, Boston 35, Mass.
Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N. Y.
Wiley Mfg. Co., Port Deposit, Md.
A. R. Wilfley & Sons, P. O. Box 2330, Denver 1, Colo.
D. T. Williams Valve Co, Div. The Schaible Co., 5801 Mariemont Ave., Cincinnati 27, Ohio
Williams Patent Crusher & Pulv. Co., 810 Montgomery St., St. Louis 6, Mo.
Willson Products Div., Ray-O-Vac Co., 200 Thorn St., Reading, Pa.
Wilmot Engineering Co., 8 West Broad St., Hazleton, Pa.
L. J. Wing Mfg. Co., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Government Standard Scale Works, Inc., 25 & Hawthorne Sts., Terre Haute, Ind.
Winter-Weiss Co., 2201 Blake St., Denver 5, Colo.
Wire Rope Corp. of America, Inc., 609 North Second St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Wise Co., O. B., P. O. Box 42, West End & Dale Ave., Knoxville 1, Tenn.
Wood Shovel & Tool Co., Roosevelt & Clark Ave., Piqua, Ohio
T. B. Woods Sons Co., Chambersburg, Pa.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc., P. O. Box 127, Sunnyvale, Calif.
J. W. Woomer & Associates, 821 Oliver Bldg., Pittsburgh 22, Pa.
Worthington Corp., 421 Worthington Ave., Harrison, N. J.
Wright Hoist Div., American Chain & Cable Co., Inc., 1100 E. Princess St., York, Pa.
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc., 1419 Illinois Ave., Sheboygan, Wisc.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.
Wyssmont Co., Inc., 42-01Q 27 St., Long Island City 1, N. Y.

Y

Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.
Yardley Plastics Co., 142 Parsons Ave., Columbus 15, Ohio
Yardney Electric Corp., 40 Leonard St., New York 13, N. Y.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngston 1, Ohio

Z

J. Z. Zurn Mfg. Co., 1960 Pittsburgh Ave., Erie, Pa.
J. Z. Zurn Mfg. Co., American Flexible Coupling Div., 1801 Pittsburgh Ave., Erie, Pa.

The **BOWDIL**® co.

ORIGINATORS OF THROW-AWAY BITS; MANUFACTURERS OF BARS, BITS, CHAINS AND OTHER PRODUCTS FOR COAL MINING; CUSTOM MACHINERY DESIGNERS AND BUILDERS; HEAT-TREAT SPECIALISTS; SALES AGENTS FOR THE CINCINNATI ELECTRIC DRILL.

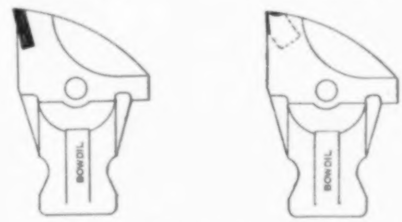
BOWDIL BITS

NEW I-29 CONCAVE

Patented concave design increases bit clearance, assures longer wear without increased power consumption. Made from special steel, rolled, with concave faces. Tests in hundreds of mines have proven these Bits last 15% to 20% longer. Bowdil makes the right size and shape bit for every mining condition, to fit all types of chain.

NEW CARBIDE TIP BITS

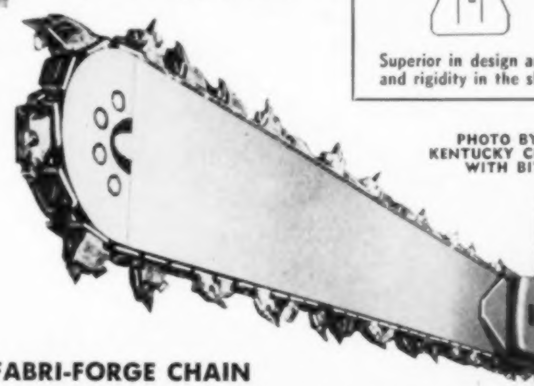
No. 1-27N3 No. 1-27N5



Superior in design and construction, with great strength and rigidity in the shank and clamping method.

BOWDIL CUTTER BARS

are designed for extra strength and power saving. Rivet-free body, Z bar construction, wide wearing strips make it the sturdiest bar in mining. Bowdil Bars are standardized to fit all mining machines.



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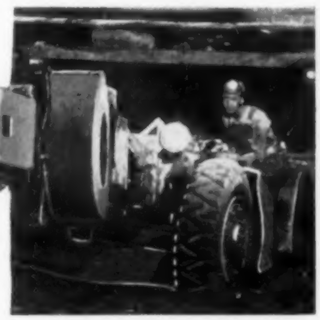


FABRI-FORGE CHAIN

Rugged, easy to maintain, the dropforged lug body stands up under heavy wear with breakage practically eliminated. A major improvement is the true-running radial track guide.

NOW AVAILABLE WITH BIT OPENING ½" x 1" (takes all type bits)

NEW 6-IN-ROW RIPPER HEAD

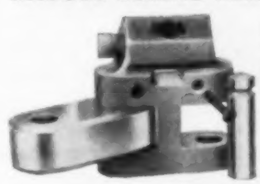
Using 6 renewable independently adjusted Cutterbars, with all 6 Chains similar in kerf and lacing arrangement for interchangeability. All 6 spockets interchangeable. Improved design head drive shaft and sprocket assembly using 2 piece sprockets to maintain extreme tension to the shaft.

These are only a few of the features and advantages in this modern Ripper Head for Continuous Mining. Ask a Bowdil representative or write for more detailed information.

SPROCKETS FOR ALL MINING MACHINES

Bowdil Sprockets are made from special heat-treated alloy steel and designed for hard wear. Our stock of over 100 different styles includes clutch, spline and keyed types—various tooth designs of 4 to 13 teeth.

NEW TRIMMER CHAIN for all makes of CONTINUOUS BORING MACHINES



Great strength and flexibility. Uses Bowdil Throwaway or ½" x 1" Shank Bits. Chain pitch may be varied by changing couplers only. NOTE COUPLING PIN DESIGN . . . chains may readily be assembled or dis-assembled with use of small hand tools.

SALES ENGINEERS IN—Whitesburg, Kentucky—West Frankfort, Illinois Charleroi, Pennsylvania — Denver, Colorado — Big Stone Gap, Virginia Danville, West Virginia — Canton, Ohio — Birmingham, Alabama Helper, Utah—Kansas City, Missouri—Centerville, Iowa—Topeka, Kansas New Castle, England — Alberta, Canada

The **BOWDIL**® co.

BOYLAN AVE. S.E. CANTON 7, OHIO

PHONE GLendale 6-7176

WORLD'S BEST COAL FILTER

A new "Hy-Flow" design that improves operating efficiency in disc type filters combined with the Agidisc function of maintaining constant particle suspension makes the Eimco "Hy-Flow" Agidisc Filter, shown above, industry's most versatile coal fine dewaterer.

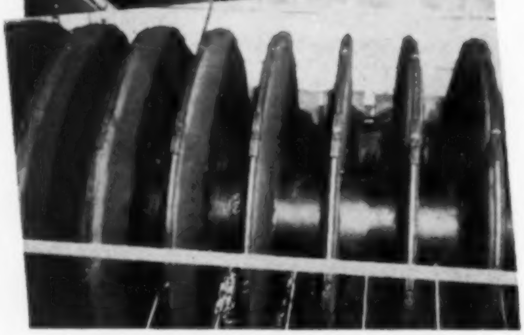
Enlarged ports, streamlined passages and direct flow are features of the "Hy-Flow" design. This allows unrestricted passage of liquids and gases from the filter media through the valve.

Vacuum loss is minimized since turbulence and right angle resistance bends are reduced. The "Hy-Flow" Agidisc includes newly designed valves, disc sectors, sector bells and trunnion barrels.

Comparison records of these filters in operation on the same feed as other filters substantiate advantages of the "Hy-Flow" design. Coal fines can be dewatered to a lower moisture content at less cost than with any other filter.

Standard Eimco Disc Filters are operating very satisfactorily in many of the Nation's top coal washing plants. The premium "Hy-Flow" design is recommended for plants where specifications require greater efficiency and clearer filtrates — where no additional treatment is needed before transfer of washwater to receiving waters.

It will be financially sound for you to review your filtering operation with an eye toward the Eimco "Hy-Flow" design. Or better still — send details to the Eimco Filtration Division. Let them apply their research and field knowledge to help you determine the proper route to better filtration and greater profits.



EIMCO AGIDISC FILTERS dewatering fine coal. NOTE — smooth, evenly distributed cake formation.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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INDEX TO GUIDEBOOK ADVERTISERS

Geographical Listing of Advertisers' District Sales Offices, Distributors and/or Sales Agents

This expanded Advertisers' Index is a new feature of COAL AGE's 1956 Mining Guidebook, designed to help users quickly locate their nearest source of supply for manufacturers advertising in this issue. A company name in black-faced type in the Classified Product Directory (page 221) denotes that more information on products offered by that manufacturer is available in advertisements on pages listed in this Index or in the Directory of Manufacturers.

This index is published as a convenience to the reader. Every care is taken to make it accurate, but C. A. assumes no responsibility for errors or omissions.

Illinois, Springfield: Matlin Corp., 2410 S. MacArthur, Phone 8-5101 & 8-6259
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Cincinnati Electric Equipment Co., 3527 Colerain Ave., MA 2127
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Winkle Electric Co., 201 Andrew Ave., Phone 3-3124
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Roeden Electric Supply Co., 808 N. Central Ave., Phone 3-0491
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912-914 Kanawha Blvd., Phone 26-157
Tri-State Air Cond. Div. of R. H. Kyle & Co., 1216 Smith St., Phone 3-9589
West Virginia, Parkersburg: Mid-Valley Supply Inc., 323 Ann St., HUdson 5-5569
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AMERICAN BRATTICE CLOTH CORP. 206

Warsaw, Ind., Phone 541

DISTRICT SALES OFFICE

Ohio, Cleveland: 1313 W. 11th St., Superior 17213

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30 Rockefeller Plaza, New York 20, N. Y.

AMERICAN MINE DOOR CO., THE 179

2037 Dueber Ave. S. W., Canton 6, Ohio, GLendale 4-7055

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Utah, Salt Lake City: National Equipment Co., 101 W. 2nd S. St. EMpire 3-8878

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404 Frick Bldg., Pittsburgh 19, Pa., GRant 1-0276

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Utah, Salt Lake City: Western Sales Engineering Co., 375 S.W. Temple, Phone 22-4311

West Virginia, Fairmont: General Mine Supply Co., 811 Maple Ave., Phone 5955

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Pennsylvania, Pittsburgh 22: Titzel Engineering & Equipment Co., 132 7th St., 952 Century Bldg.

AMERICAN STEEL & WIRE DIV., UNITED STATES STEEL CORP. 12-13, 168-169

Rockefeller Bldg., Cleveland 13, Ohio

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BALDWIN-LIMA-HAMILTON CORP., CONSTRUCTION EQUIPMENT DIV. 180

Lima, Ohio

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BIN-DICATOR CO. 216

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BIXBY-ZIMMER ENGINEERING CO 195

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BOWDIL CO., THE 283

Boylan Ave. S.E., Canton 7, Ohio, GLendale 6-7176

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West Virginia, Danville: (E. D. Caudill) Box 132, Phone 336
Utah, Helper: (V. L. Walkington)

BUILDERS PROVIDENCE, INC., DIV. of B-I-F INDUSTRIES, INC. 206

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CARDOX CORP 6-7

307 N. Michigan Ave., Chicago 1, Ill.

DISTRICT SALES OFFICES

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Pennsylvania, Library: Box 427, Colonial 3-6910
West Virginia, Camden-on-Gauley: Phone Camden-on-Gauley 2181
West Virginia, Harper: Phone Beckly 4812

CENTRIC CLUTCH CO. 192

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CENTRIFUGAL & MECHANICAL INDUSTRIES, INC. 187

146 President St., St. Louis 18, Mo., PR 6-2848

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CHEATHAM ELECTRIC SWITCHING DEVICE CO. 218

4780 Crittendon Dr., Louisville 9, Ky., EMerson 3-3571

CINCINNATI MINE MACHINERY CO., THE ... 194

Cincinnati 25, Ohio

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Illinois, Danville: W. M. Hales Co., Box 65
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Kentucky, Madisonville: W. M. Hales Co., Box 91
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Pennsylvania, Pittsburgh: Penn Machine Co., Union Trust Bldg.
Tennessee, Jellico: McComb Supply Co.
Utah, Kenilworth: Frank Armstrong
West Virginia, Huntington: Huntington Supply & Equipment Co., Box 370
Canada, Alberta, Drumheller: Gorman's Ltd.
Canada, Alberta, Edmonton: Gorman's Ltd.
Canada, New Brunswick, St. John: E. S. Stephenson & Co., 15 Dock St.
Canada, Nova Scotia, Halifax: E. S. Stephenson & Co., P.O. Box 1033

CLARKSON MFG. CO. 189

P.O. Box 72, Nashville, Ill., Phone: Nashville 7-8276; St. Louis phone: GEneva 6-1545

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COMBUSTION ENGINEERING, INC., RAYMOND DIV. . . 198

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COMPTON, INC. 204

P.O. Box 1946, Clarksburg, W. Va.

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22 N. 5th St., Indiana, Pa., INdiana 5-7189 & 5-7198

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Missouri, Kansas City: Finkhouser Equipment Co., 2425 Jefferson St.
North Carolina, Winston-Salem: J. W. Burress, 100 Waughtown St.
Ohio, Cleveland: Cleveland Contractors Equipment Co., 10904 Brookpark Rd.
Oregon, Portland 14: Blazer Machinery Co., 2136 S.E. 8th Ave.
Pennsylvania, Philadelphia 32: Service Supply Corp., 2020 W. Erie Ave.
Pennsylvania, Pittsburgh 30: Anderson Equipment Co., P.O. Box 1737
Tennessee, Nashville: McCarthy-Jones & Woodward, 723 Argyle Ave.
Texas, Dallas 19: Lumby Machine Co., 6541 Forest Park Rd. at Mockingbird Lane
Utah, Salt Lake City 10: Arnold Machine Co., Inc., P.O. Box 2220
Virginia, Roanoke: Southern Machine Co., 2745 Shenandoah Ave. N.
West Virginia, Charleston: West Virginia Tractor & Equipment, P.O. Box 473

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Kent, Ohio

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DISTRIBUTORS

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Pennsylvania, Frostburg: Stockdale Mine Supply
Pennsylvania, Scranton: Rotary Drilling Equipment, 221 W. Olive St.

DENVER EQUIPMENT CO . . . 219

1400 17th St., Denver 17, Colo., CHerry 4-4466

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Utah, Salt Lake City: P.O. Box 705, Phone 6-1559
Canada, British Columbia, Vancouver: Credit Foncier Bldg., Marine 4918
Canada, Ontario, Toronto: 220 Bay St., EMpire 3-8836

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Kentucky, Louisville: Bogie Equipment Co., 4397 Poplar Level Rd.
Kentucky, Madisonville: Bogie Equipment Co., U.S. Route 41 N.
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Ohio, Cleveland 13: Great Lakes Diesel Co., 1064-66 11th St. W.
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Ohio, Dayton: Flack Equipment Co., P.O. Box 953, 1240 McCook Ave.
Ohio, Steubenville: Ray C. Call, Inc., 4030 Sunset Blvd. Ext.
Ohio, Toledo: Great Lakes Diesel Co., 2012 Front St.
Ohio, Youngstown: Great Lakes Diesel Co., 250 E. Indianola Ave.
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Pennsylvania, Kingston: Standard Equipment Co., 340-344 Pierce St.
Pennsylvania, Philadelphia 37: Frantz GM Diesel, Inc., 4152 E. Thompson St.
Pennsylvania, Pittsburgh 6: Highway Equipment Co., 6465 Hamilton Ave.
West Virginia, South Charleston: Ray C. Call, Inc., McCorkle Ave., P.O. Box 8213
West Virginia, Fairmont: Ray C. Call, Inc., Route 19, P.O. Box 771

DRAVO CORP. 207

Neville Island, Pittsburgh 25, Pa.

DUFF-NORTON CO. 167

2709 Preble Ave., Pittsburgh 30, Pa.

EIMCO CORP., THE 284

Salt Lake City 10, Utah

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Texas, El Paso: Mills Bldg.
Texas, Houston: 4008 Purdue St.
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ENTERPRISE WHEEL & CAR CORP. 172

Bristol, Va.

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West Virginia, Bluefield: P.O. Box 182, Davenport 7-6640

DISTRIBUTOR

Alabama, Homewood: L. D. Brooks, P.O. Box 5725, Tremont 1-7418

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Illinois, Chicago 9: 5335 S. Western Blvd. WAlbrook 5-9800
Illinois, Peoria: 423 1st Nat'l Bank Bldg., Phone 4-5051
Indiana, Indianapolis 4: 325 Bankers Trust Bldg., MElrose 5-6727
Missouri, Kansas City 23: 129 Belmont Blvd., BEnton 1-6300
Missouri, St. Louis 8: 3928 Lindell Blvd., OLive 2-1310
New York, New York 36: 25 W. 43d St., BRyant 9-8100
North Carolina, Charlotte 6: 106 N. Caldwell St., FRanklin 5-7966
Ohio, Cincinnati: Rm. 426, 307 E. 4th St., Main 1435
Ohio, Cleveland 14: 1014 Engineers Bldg., Cherry 1-6231
Oregon, Portland 5: 1224 S.W. Morrison St., CApital 2-3778
Pennsylvania, Kingston: 33 Popular St., BUtler 7-8294
Pennsylvania, Philadelphia 4: 101 N. 33d St., EVergreen 2-5858
Pennsylvania, Pittsburgh 16: 1608 Potomac Ave., FIeldbrook 1-2832
Tennessee, Memphis: 902 Dermon Bldg., Jackson 6-5842
Texas, Dallas 1: 2133 McKinney Ave., Riverside 9977
Utah, Salt Lake City 7: P.O. Box 133, Murray Branch, ELgin 9-5766
Washington, Seattle 4: 1919 Smith Tower Bldg., Elliott 1377
West Virginia, Charleston: P.O. Box 1562, CHarleston 6-81201

FALK CORP., THE 178

Milwaukee, Wis.

DISTRICT SALES OFFICES

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Illinois, Peoria: 800 S. Adams St., Phone 6-0433
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Kentucky, Knoxville 17: (Bowditch & Co.), 1311-C N. Broadway, Phone 4-2513
Maryland, Baltimore 12: 4231 Greenmount Ave., TUxedo 9-4969
New Jersey, Newark 5: 100-102 Parkhurst St., BIgelow 2-5300
Ohio, Akron 9: (B. W. Rogers Co.) 850 S. High St., HEmlock 4181
Ohio, Cincinnati 2: 609 American Bldg., Main 2364
Ohio, Cleveland 15: (P. M. Kline & Assocs.), 2036 E. 22nd St., CHerry 1-1171
Ohio, Dayton 2: 410 W. 1st St., MIchigan 4833
Pennsylvania, Pittsburgh 19: 410 Grant Bldg., ATlantic 1-1139
Pennsylvania, Upper Darby: 205 Long Lane, FLanders 2-5014
Virginia, Richmond 19: (Williamson & Wilmer), 617 Mutual Bldg., Phone 3-9003
West Virginia, Charleston 2: 3145 Washington St. W., RIverside 4-1821
West Virginia, Fairmont: 801 Coleman Ave., Phone 3453

GATES RUBBER CO., THE... 175

999 S. Broadway, Denver 17, Colo.

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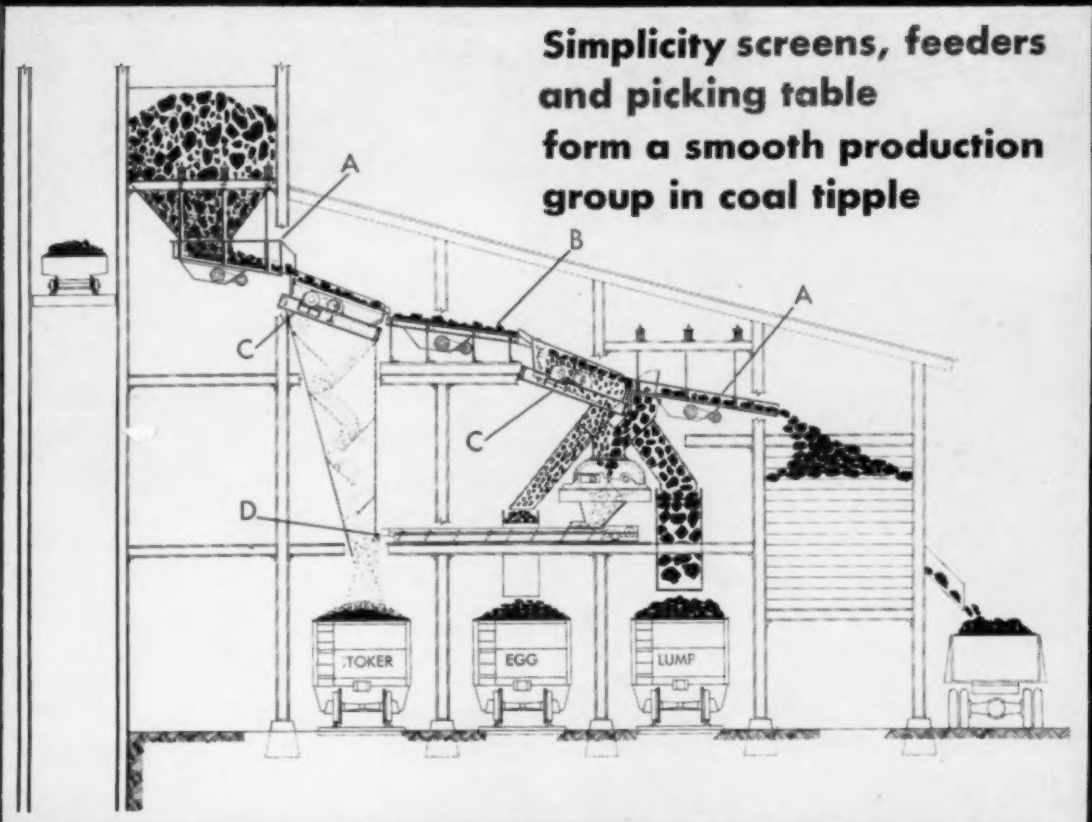
CRANES
20-100 TON



A SIMPLICITY OS-A-VEYOR FEEDERS spring and cable suspended, give a controlled, uniform flow of coal with a minimum of bridging in the bin.

B SIMPLICITY OS-A-VEYOR PICKING TABLES distribute a uniform thin bed of material for the easy removal of undesirable material.

C SIMPLICITY GYRATING SCREENS provide a large capacity and quick, accurate sizing. Patented balance feature transmits little or no vibration to the supporting structure.

D SIMPLICITY 32 SERIES BALANCED PAN TYPE CONVEYORS speed the flow of coal where space is at a minimum and little supporting structure is available.

These Simplicity Screens, Feeders and Os-A-Veyors can greatly speed and simplify the sizing and movement of coal at your tipple. For further information or suggestions, consult a sales representative or our engineers at Durand.

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Simplicity
TRADE MARK REGISTERED

ENGINEERING COMPANY • DURAND 19, MICHIGAN

SALES REPRESENTATIVES IN ALL PARTS OF THE U.S.A.

FOR CANADA: Simplicity Materials Handling Limited, Guelph, Ontario.

FOR EXPORT: Brown and Sites, 50 Church St., New York 7, N. Y.

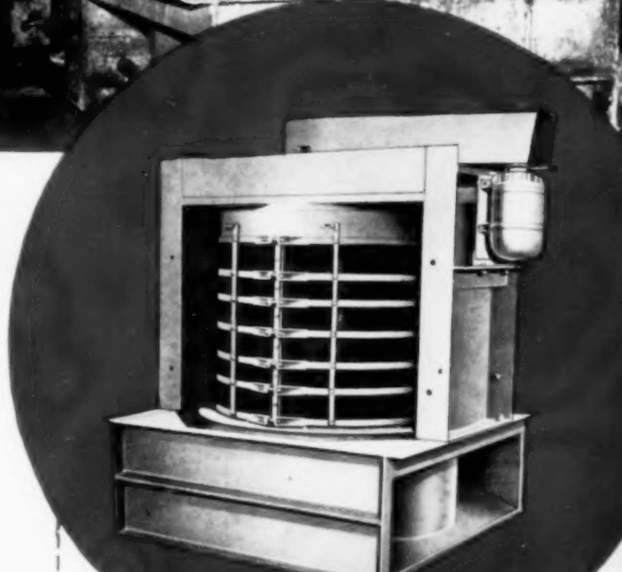

These four Symons V-Screens are installed at Jamison #9 Mine of Consolidation Coal Company (W. Va.) where they are used for dewatering 3/8" x 10 mesh bituminous coal.

SYMONS® V SCREENS

give users maximum efficiency in FINE COAL PREPARATION

The SYMONS V-SCREEN combines centrifugal force with gravity to do a better screening job—make sharper separations—and give you a much dryer product with less degradation than other dewatering methods. It will reduce surface moisture by at least 50%, even on fine coals . . . requires only 5 hp to operate under full load . . . and is the *only* screen that does not depend on gravity alone to size or dewater.

The capacity of the Symons V-Screen is over twice that of a conventional type vibrating screen, per square foot . . . with average tonnages ranging from 35 to 70 tph per screen. In addition, its new screening principle gives extremely long screen cloth life.



FEATURING:

- HIGH CAPACITY
- EXTREMELY ACCURATE SIZING, EVEN IN THE FINER MESHES
- HIGHLY EFFICIENT DEWATERING
- FULLY ENCLOSED — DUSTLESS OPERATION
- EASY REPLACEMENT OF SCREEN CLOTH
- MINIMUM FLOOR SPACE REQUIRED
- LOW COST OPERATION

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Write for your copy of Bulletin 243, which gives the full story on Symons V-Screens.

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